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FAILURE MODES, EFFECTS
AND
CRITICALITY ANALYSIS (FMECA)
OF
CATEGORY III INSTRUMENT
LANDING SYSTEM

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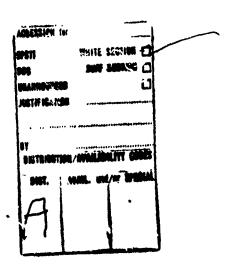
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### 16. Abstract

\*A Failure Modes, Effects and Criticality Analysis (FMECA) is used to optimize system performance by identification (and subsequent elimination) of all potentially hazardous failure modes affecting either personnel safety or operational mission success. The in-depth systematic approach of such an analysis provides the quantitative assurance that the system design has achieved the highest standards of system reliability and integrity.

The FMECA performed under contract number DOT-FA71WA-2635 for the FAA on the Texas Instruments Incorporated FAA Mark III ILS identified changes/modifications which were required in order for the system to comply with the quantitative requirements imposed upon the reliability of the system. These changes/modifications have been incorporated into the design and, as a result, the design meets and exceeds the required reliability criteria set for the system. Another major valuable output of the FMECA deals with performance assurance measures (preventive maintenance). All relevant hidden equipment failure modes are identified within the analysis and, based upon allowable provabilities of occurence, their respective preventive maintenance frequencies are specified.

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#### 1.0 INTRODUCTION

The increase of aircraft transportation during the last ten years has been nothing less than phenomenal. To accommodate this increase greater demands must be imposed upon aircraft and their associated ground support equipments. Higher equipment reliabilities and extremely low probabilities of mission failure are natural requirements which must be fulfilled in this area with the aid of modern technologies.

An instrument landing system (ILS) is one such ground support equipment which embodies these requirements. The ILS, providing guidance to approaching or landing aircraft under adverse weather conditions, must employ "optimum" design and reliability to ensure personnel safety. This is especially true in the Category III ILS which provides guidance information from the coverage limit of the facility at which it is installed to, and along the surface of the runway. To ensure that the "optimum" in equipment performance is achieved, a qualitative system analysis which stratifies all possible modes of failure, their criticality and effect on mission success must be accomplished. Such an analysis, called a Failure Modes, Effects and Criticality Analysis (FMECA), has been performed by Texas Instruments Incorporated on its Category III ILS (FAA Mark III ILS) and is the subject of this report.

## 1.1 Safety Requirement

It is impossible to achieve the implementation of a system with infinite reliability and safety; therefore, it becomes necessary that some safety/reliability goal be established to enable the relative safety of the ILS to be determined. For Category III operations, there is a brief time period during which the safety of the aircraft becomes completely dependent upon the integrity of the electronic system. Failure of certain critical ground based components during this time period could possibly result in a catastrophic event. In an attempt to quantify the safety of the equipment, the figure specified is a probability of 1 failure in ten million landings. This figure was derived by the British Air Registration Board from human mortality data and safety records of aircraft. This requirement indicates that the landing operation under Category III conditions would be safer than a person can predictably expect to be in his normal day-to-day activities. The value, if anything, is on the stringent side, in that it is not possible to categorically state that a given failure will be catastrophic, but only that it will produce a potentially hazardous situation that may be catastrophic if the proper corrective action on the part of the aircraft crew is not taken.

The relationship of mean-time-between-failures (MTBF) to the overall system reliability requirement is as follows:

The predicted localizer hardware MTBF is approximately 1200 hours and that of the glide slope is 1800 hours. Any given failure in the equipment will contribute to a lower MTBF but will not necessarily interrupt the operation or even degrade the operational category status (Category III or II). This is possible through appropriate equipment redundancy so that when individual component failures occur, continued operation may still be possible. Consequently, it is possible for the probability of operational failure to be far less than a component failure. Given that the ground system is fully operational at the inception of a Category III ILS approach, the probability of malfunction of the radiated signal (both localizer or glide slope) during the critical part of the approach (defined as ten seconds for the localizer and five seconds for the glide slope) should be less than one in ten million which corresponds to an equivalent MTBF of operation in the order of 27,000 hours.

#### 2.0 PURPOSE

The primary purpose of performing an FMECA upon the Category III ILS is to insure that the equipment design is such that the probability of a potentially hazardous failure (loss of signal or radiation of an erroneous signal) during the critical phase of Category III landing is less than 1 x 10°. In addition, a number of secondary objectives exist: (1) to reveal hazardous failure modes jeopardizing personnel safety and/or system performance status; (2) to enumerate all relevant functional failure modes along with their effect and failure rate; (3) to serve as a documented aid in the troubleshooting process of field failures in the future; (4) to serve as an objective evaluation of both the equipment specification and its design; and (5) to determine the frequency of preventive maintenance in checking for hidden failures.

#### 3.0 SYSTEM DESCRIPTION

A Category III ILS provides aircraft with guidance information from the coverage limit of the facility to, and along, the surface of the runway. The system under analysis has operational performance of Category III, that is, operation with no decision height limitation. Initially the system will be used in Category IIIA operations in which the pilot will make use of external visual references during the final phase of landing and with a runway visual range (RVR) of not less than 700 feet. The ILS must be suitable for eventual use by automatic control system for rollout, which will be used in Category IIIB operations with runway visual ranges down to 150 feet.

The ILS system basically consists of two separate stations - the localizer and the glideslope; depicted in simplified block diagram form by figures 3-1 and 3-2 respectively. In addition to these stations, a central point for station control and the display of station status exists at the control tower. Up to three marker beacons are also utilized in a typical ILS installation. However, any description of the marker beacons will be provided since they will not be considered in this analysis.

## 3. 1 General Descriptions

The localizer provides guidance in the horizontal plane to aircraft engaging in approaches to, and landing at, airfields. The localizer antenna group radiates two VHF carriers, each amplitude modulated by 90 and 150 Hz and both carrier frequencies within a particular VHF channel. The radiation field pattern produces a course sector with one tone predominating on one side of the course line (runway center line) and with the other tone predominating on the opposite side. Along the course line, the 90Hz and 150Hz modulations have the same levels. Being a two-frequency, capture effect system, one of the carriers (course) provides a radiation field pattern coverage in the front course sector; the other carrier (clearance) provides a radiation field pattern coverage outside that sector to ±60 degrees from the course line.

The glideslope station provides guidance in the vertical plane. It produces a UHF composite field radiation pattern which is amplitude modulated by 90 and 150 Hz. The pattern provides a straight line descent path in the vertical plane containing the runway center line, with the 150 Hz tone predominating below the path angle and the 90 Hz tone predominating above the path angle. In addition to this course coverage, a clearance UHF carrier is modulated by 150 Hz to provide low angle coverage. Both carriers (course and clearance) are within a particular glideslope UHF channel.

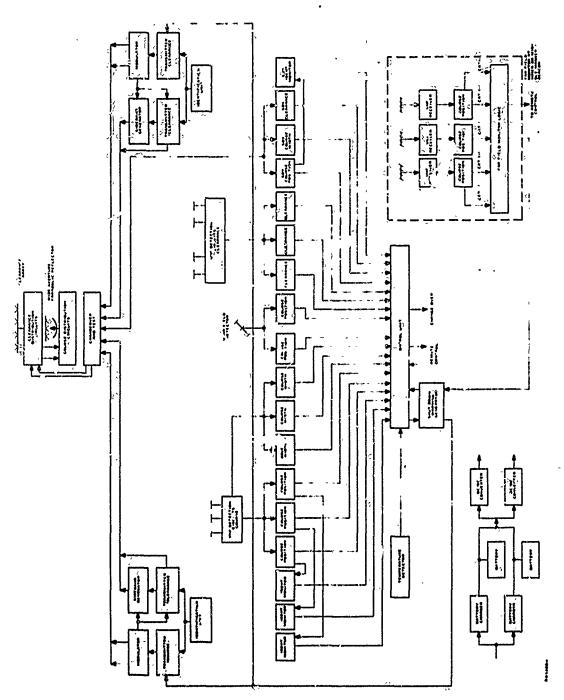
## 3.2 Localizer

Referring to figure 3-1, there are two transmitter sections incorporated into the localizer station. One transmitter is designated as the main transmitter and the other, the standby transmitter. Automatic changeover capabilities are provided. While the main transmitter radiates into the antenna system, the standby transmitter will be operating into dummy loads. Whenever the main transmitter shuts down due to some equipment failure, the standby transmitter is transferred immediately to the antenna system.

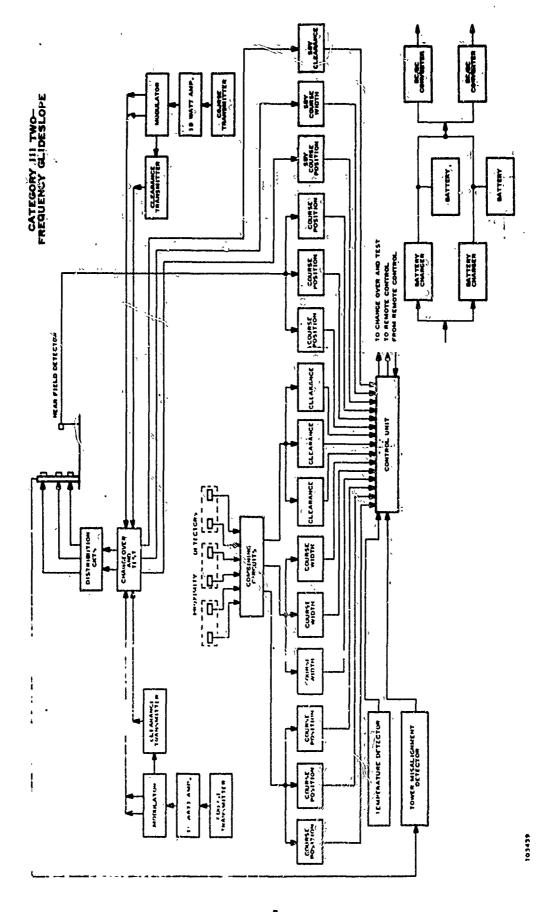
A brief explanation of each transmitting unit is in order. The course transmitter delivers a VHF carrier (108-112MHz) frequency to the solid state modulator where it is modulated by 90 and 150 Hz tones. Two signals (figure 3-2) are generated by the modulator: carrier plus sidebands (C+SB) and sidebands only (SBO). The modulator also delivers to the clearance transmitter a composite of low frequency 90 and 150 Hz tones to modulate the clearance carrier, generating the clearance C+SB. In addition, low frequency 90 and 150 Hz tones and clearance carrier are supplied to the sideband generator where the clearance SBO is generated. The identification unit, which provides the pilot identification of the runway and the approach direction, generates a 1020 Hz identification signal which modulates both the course and clearance carriers.

The output signals from the main and standby transmitting units are routed to the changeover and test unit where transmitter transfer capabilities are accomplished. Signals received from the control unit determine which transmitter operates into the antennas - main or standby. When the main transmitter is connected to the antenna system, the standby transmitter operates into dummy loads. When the standby unit is connected to the antenna system, the main unit is turned off. Within the change-over and test unit there exists circuitry for use in monitoring standby transmitter parameters.

From the changeover and test unit, the course and clearance transmitter signals (C+SB and SBO) are fed to the course and clearance distribution circuits respectively. Each of the distribution circuits merely distributes the C+SB and SBO signals to the localizer antennas. Phasing relationships and signal combinations are accomplished within the distribution circuits so that the proper field radiation pattern is established via the antennas. The antenna assembly consists of a parabolic reflector with directional exciters and a clearance array. The parabolic reflector with directional exciters (three directional antennas) is used in es-



Category III Two-Frequency Localizer Wide Aperture Configuration Block Diagram Figure 3-1.



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Category III Two-Frequency Glide Slope Block Diagram Figure 3-2.

tablishing the course field radiation pattern; however, to establish the clearance field radiation pattern both the clearance array (consisting of 4 antenna elements) and the course antenna system are required.

To provide integral monitoring ability of the radiated signal parameters, proximity detectors are utilized. Each transmitting source is sampled by a proximity probe. The captured signals are then combined (in the distribution circuit cabinets) to provide the proper signals with which system parameters are monitored. The system parameters which are monitored are: course position, displacement sensitivity, carrier power level, percentage modulation, identification signal, and clearance monitoring.

Triplicate monitoring of each of these parameters is incorporated as shown in figure 3-1. When the tolerance limit of any parameter is exceeded, an alarm signal from each of the respective monitor channels is fed to the control unit, from which a transfer to the standby transmitting unit is initiated. The control unit acts upon a 2 of 3 vote to initiate the transfer.

In addition to the integral monitoring of system parameters, near field and far field course position monitoring is also incorporated. The near field monitoring utilizes a single yagi antenna to provide dual monitoring ability. The far field monitoring utilizes three Yagi antennas feeding triplicate VHF receivers and triplicate monitor channels with a 2 of 3 vote. Both near field and far field alarm signals are delayed to prevent disturbances created by aircraft overflights and landings from causing equipment alarm and shutdown.

The same system parameters are monitored for the standby transmitting unit as for the main transmitting unit. However, only single monitoring is incorporated. Upon an alarm from any standby monitor, the standby transmitting unit will be shut down after a nominal 5 second time delay.

The far field monitor has its own alarm processing circuitry to minimize the quantity of telephone lines needed for remote transmission. Each far field monitor channel provides two alarm outputs - a Category III alarm and a Category II alarm. The difference between these two alarm outputs is merely in tolerance limits. A two of three vote is utilized for both the Category II and Category III alarms. Time delays are associated with the final alarm outputs for both categories; however, the Category III alarm time delay is accomplished at the remote control unit in the control tower (the Category III alarm signal is conveyed directly to the tower where performance downgrade is accomplished). Besides a general power/temperature alarm and a

far field monitor bypass signal, three signals are sent to the localizer control unit - a monitor mismatch, a shutdown alert, and a shutdown. A monitor mismatch signal indicates that one of the three Category II monitor channel alarms has existed over a definite time period (nominal 120 seconds). A shutdown signal indicates that 2 of 3 Category II monitor channel alarms have existed over a set time period (nominal 70 seconds). When received at the localizer control unit, this shutdown signal will immediately shut down the entire localizer station. The shutdown alert signal precedes the shutdown signal by a nominal 5 seconds. The shutdown alert signal initiates a shutdown warning signal (within the control unit) which is transmitted to the pilot to give him an advance warning of the forthcoming shutdown.

The localizer control unit processes alarm signals received from the monitor channels. If only one alarm is received from any monitor channel set, a MONITOR MISMATCH lamp located on the control unit front panel will illuminate. All integral monitor alarms require a two of three voting to initiate a transfer command. An actual transfer will be accomplished only if the stand-by transmitting unit is available while the main is operative. If either the standby transmitter is operative (on the air) or if it is shut down, a transfer command leads to a localizer shutdown. If both near field monitors alarm, a direct localizer shutdown will result after the nominal 5 second time delay. A shutdown alert is also initiated prior to the shutdown command of the near field alarms.

In addition to the alarm processing already described, the control unit:

- 1. Provides signals to the remote control unit showing the status of the main and standby transmitting equipment.
- 2. Provides signals to the remote control unit downgrading the facility performance Category III status to Category II if the standby equipment is either not available or is on the air.
- 3. Processes transmitter "cycle" commands received from the remote control unit.
- 4. Visually displays all alarm conditions and transmitter status.
- 5. Provides for the selection of the main transmitting unit.
- 6. Provides for the bypassing of all monitor channels.
- 7. Provides for the memorization or non-memorization of monitor alarms.

- 8. Provides for the selection of command control from either the remote control unit or the localizer control unit.
- 9. Inhibits restoration of radiation for at least 20 seconds after localizer radiation has been shut down.
- 10. Provides for testing the integrity of both abnormal indication and monitor alarm lamps with a bulb test switch.
- 11. Provides signals to the remote control unit showing either
  (1) monitor alarm abnormals or (2) power/environmental
  abnormals. (Note: power/environmental abnormals downgrade system performance status from Category III to
  Category II after a preset time delay.)

With regards to system power supplies, redundancy is highly incorporated. The two main battery chargers are connected in parallel, each possessing the capability of independently supplying the load current and voltage. Each battery charger has its own respective battery which it keeps fully charged. Two DC/DC converters, receiving their input from the common charger output voltage (+28 volts), produce the remaining system de voltages. Each converter voltage is virtually in parallel with the other respective converter voltage, thus providing a dual redundancy of all system de supply voltages.

## 3.3 Glideslope

The simplified block diagram of the glideslope station is presented in figure 3-1. As is evident the configuration of the station is very similar to that of the localizer. Some of the major differences are: (1) the glideslope does not possess either a far field monitor or an identification unit/monitors (2) the glideslope has an antenna tower misalignment detector (3) triplicate near field monitors are utilized for the glideslope (4) no shutdown alert warning signal is provided.

The transmitter section is also slightly different. The course transmitter delivers a UHF carrier (328.6 - 335.4 MHz) frequency which is amplified by the 10 watt amplifier. This amplified carrier is then delivered to the solid state modulator where, as for the localizer, it is modulated by 90 and 150 Hz tones. The two signals, C+SB and SBO are generated by the modulator. In addition the modulator also provides a low frequency 150Hz signal used for modulating the clearance carrier within the clearance transmitter. The clearance signal is only C+SB 150 Hz.

The changeover and test unit provides the same function at that of the localizer - transfer transmitter signals of the main and standby unit either into the antenna system (including distribution circuits) or into dummy loads. Also within the changeover and test unit there exists circuitry for monitoring of the standby transmitter parameters.

From the changeover and test unit, the three signals (course C+SB, course SBO, and clearance C+SB 150) are routed to the distribution circuits where these signals are combined and distributed to the three 2-lambda glideslope antennas. Correct phase relationships are established within the distribution circuits. The three 2-lambda antennas (M-array) are identical and are mounted on the tower at 3 different heights (H, 2H, 3H). H is dependent both upon the radiating frequency and the glide path angle.

Proximity field detectors are employed to provide integral monitoring ability of the radiated signal parameters. The UHF combining circuits combine the signals provided by the probes so that parameter monitoring can be accomplished. The parameters to be monitored are: path alignment (course position), carrier power level, percentage modulation, path width (displacement sensitivity) and the clearance signal. As in the localizer, tripplicate monitoring of all parameters is incorporated.

The second of th

In addition to integral monitoring, near field monitors are provided to monitor the path angle (course position). The near field monitor antenna couples the appropriate signal to three parallel monitor channels. A two of three vote for monitor channel alarms is utilized. Since aircraft overflights may cause field disturbances which will create near field alarms, the alarms are delayed a nominal 2 seconds at the control unit. "True" near field alarms lead directly to station shutdown.

As in the case of the localizer, the same standby parameters are monitored for the standby transmitting unit as for the main transmitting unit. Again, only single parameter monitoring is incorporated.

A glide slope antenna tower deformation monitor is employed to verify the integrity of the tower. If misalignment or deformation of the antenna tower persists for a nominal 135 seconds, an alarm is provided to the control unit which will shut down the entire glideslope station. The misalignment detector is mounted at the top of the antenna tower and is nominally set to detect a five inch deflection at the top of the tower.

The glideslope control unit utilizes the same printed wiring boards as the localizer. (Actually there is one less board used in the

glideslope). Hence all functional operations and displays of status are identical. For minor differences (such as a misalignment detector alarm versus the far field monitor alarms) strap options are employed.

## 3.4 Remote Control Unit

The remote control unit, figure 3-3, receives inputs from the localizer station, the glideslope station, and each of the marker beacons. It is used for the display of all status information from these stations. It also provides for remote cycling capability of transmitting units for each station (cycle sequence: MAIN-OFF-STANBY-OFF).

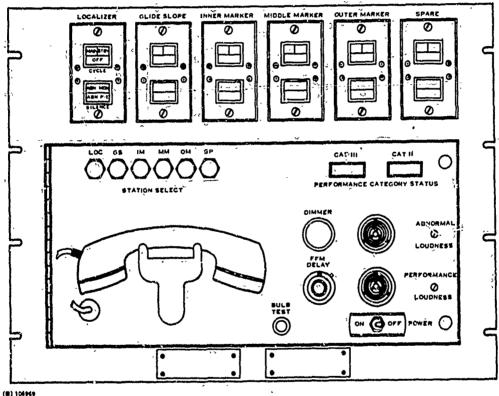


Figure 3-3. Remote Control Unit

Two ABNORMAL indications are provided for each station - MONITOR ABNORMAL and POWER/ENVIRONMENTAL ABNORMAL. The MONITOR ABNORMAL lamp is illuminated whenever:

- The main transmitter is not operational.
- A mismatch exists on one of the monitor channel sets (i. e. one monitor channel out of three is in alarm).
- e A main inhibit is generated (note: a main inhibit inhibits the main monitor channels).

- An alarm has occurred on the standby monitor channels. (the alarm may be due to either a failure in the standby transmitter or in one of the standby monitor channels).
- For the localizer, a far field shutdown alarm has occurred; for the glideslope, a misalignment detector alarm has occurred.
- The monitors locally bypassed (MLB) mode of operation is selected. (Note that under this condition the ABNOR-MAL lamp will be flashing).

The POWFR/ENVIRONMENTAL ABNORMAL is illuminated when ever:

- One of the DC/DC converter voltages fails.
- The temperature limits are exceeded.
- The primary power to either of the two battery chargers fails.
- Either of the battery chargers fail.
- The terminal battery voltages drop below a preset level.
- For the localizer, a power/temperature alarm occurs at the far field monitor.

When either of these abnormals are generated an audible alarm is sounded. By depressing the SILENCE switch, the audible alarm is turned off.

An ILS performance category status is also provided for visual display at the remote control unit. The Category III lamp is illuminated only if all of the conditions listed below are satisfied.

- 1. Localizer main transmitter is on the air.
- 2. Localizer standby transmitter is available.
- 3. Localizer far field course monitors see the course position parameter within Category III tolerance limits (adjustable 20 second time delay available).
- 4. Localizer monitor channel inhibit is not present.
- 5. Localizer terminal battery voltage is above a preset level.
- 6. Glideslope main transmitter is on the air.
- 7. Glideslope standby transmitter is available.
- 8. Glideslope monitor channel inhibit is not present.

- 9. Glideslope terminal battery voltage is above preset
- 10. Outer marker beacon is on with no rf level or identifi-
- 11. Middle marker beacon is on with no rillevel or identification alarm.
- 2. Inner marker beacon is on with no rf level or identification alarm.
- 13. Distance measuring equipment (DME) is within tolerance (if applicable).
- 14. The "absence" of localizer POWER/ENVIRONMENTAL ABNORMAL condition. (A time delay of up to 3 hours is used for this condition).
- The absence of glideslope POWER/ENVIRONMENTAL ABNORMAL condition. (A time delay of up to 3 hours is used for this condition).

The Category II lamp is illuminated only if all of the conditions linted below are satisfied.

- 1. Either the localizer main or standby transmitter is on the air, provided that no monitor channel inhibit exists.
- 2. Either the glideslope main or standby transmitter is on the air, provided that no monitor channel inhibit exists.
- 3. The Category III indicator lamp is off.

- 4. Outer marker beacon is on with no rf level or identification alarm.
- 5. Middle marker beacon is on with no rf level or identification alarm.
- 6. Inner marker beacon is on with no rf.level or identification alarm.

Whenever a change in performance category occurs, a momentary buzzer is triggered.

## 4.0 PROCEDURE

The following steps briefly summarize the general approach taken in this analysis:

- 1. The functional block diagram of the system is drawn, exhibiting all relevant signal flow paths between the various functional assemblies. In addition to the system block diagram, detailed functional descriptions (such as Boolean algebraic expressions and simplified assembly block diagrams) are provided when signal flow characterization is not readily attained at the system block diagram level.
- 2. Each functional entity in the system block diagram is then analyzed for all possible failure modes which have a direct effect on the system operational status. It should be noted that each failure mode listed reflects actual piecepart failure effects at the functional block output. The various failure mode effects and system failure indications are then tabulated.
- 3. Upon completion of the tabulation of the failure modes and effects, the failure rate of each failure mode will be calculated. That failure rate is the total failure rate of all the piecepart components which, upon failure, produce that functional failure mode.
- 4. The final step of the FMECA is the verification that system design and reliability such that the probability of a potentially hazardous failure during the critical landing phase of a Category III landing is less than 1 x 10<sup>-7</sup>. This is accomplished by developing mathematical models which entail all conceivable events (or sequence of events) that lead to one of two probabilities of system failure: (1) the loss of signal (station shutdown) or (2) the radiation of a hazardous signal (out of Category III tolerance). The probability math models for each of these conditions are determined by utilizing the failure modes and effects data. The final calculation of the probability of the Category III SSILS mission failure is then performed.

## 5.0 ASSUMPTIONS/CONSIDERATIONS

The FMECA was not performed at piecepart level but rather at the functional level, i. e., the level at which one or more distinct circuits serve a separate system operational function. In most cases this functional level neatly coincides with the assembly level of the system. To perform a piecepart analysis on a system as extensive as the SSILS was judged neither necessary nor desirable.

Prior to any failure both the localizer and glideslope are operating on main transmitting units in Category III performance status as indicated by the remote control unit CAT III status indicator. On a per station basis, Category III performance status simply implies that (1) the main transmitter is on the air, operating within Category III tolerance limits; (2) the standby transmitter is available (3) a power or environmental alarm has not existed over some preset interval of time (3 hours maximum). For descriptive purposes within this analysis, transmitting unit number 1 will be considered as main and transmitting unit number 2 as standby.

When the monitoring system of the SSILS is functioning properly (no monitor malfunctions present), radiation pattern degradations beyond the Category III tolerance limits are detected. Hence, the criteria for establishing a "true functional (or catastrophic) failure" is that it degrades the radiated signal beyond the alarm limits of the monitors.

Only single piecepart failures (open/short component failures) are considered in the determination of functional failure modes. However, multiple functional failure modes will be considered for the determination of hazardous failure conditions.

The following are excluded from the analysis:

- a. Monitor indicator circulary not affecting operational status (such as alarm memory latches, lamp drivers, bulbs, metering circuitry).
- b. Intercom c/rouitry not vital for system operation.
- c. Marker Seacons not vital for Category III operation.
- d. Heater resistors within the cabinets of the distribution circuits. Since distribution circuitry failures are considered in the analysis, the cause of failure, temperature or otherwise, is immaterial to this analysis.

The analysis of the remote control/status display is given in paragraph 10. With regards to this analysis, it will be assumed

that the operator will check the transmitter status of each stat on and determine that the CAT III status indicator lamp is lit prior to a Category III landing.

The following failure modes are considered not hazardous:

- a. Loss or degradation of the identification signal.
- b. Loss or degradation of the shutdown alert signal.
- c. Generation of an erroneous shutdown alert signal.
- d. Loss of Category II near field monitoring ability.
- e. Generation of erroneous power/temperature alarms.

The critical landing phase period for the localizer is 10 seconds; for the glideslope 5 seconds.

The probability of failure P(F) is equal to  $\lambda t$ .

Note: The probability of success is given by the expression

$$P(S) = e^{-\lambda t}$$

Utilizing the exponential expansion,

$$P(S) = e^{-\lambda t} = 1 - \lambda t + \left(\frac{\lambda t}{2}\right)^2 - \left(\frac{\lambda t}{6}\right)^3 + \dots$$

For values of kt << 1,

$$P(S) = 1 - \lambda t$$

Therefore the probability of failure is:

$$P(F) = 1 - P(S) = 1 - (1 - \lambda t) = \lambda t$$

External runway disturbances such as aircraft overflights and runway activity have an adverse effect on the radiated localizer signal at the far field. The parameter of interest at the far field is the difference in depth of modulation (DDM). This parameter is affected by such disturbances and, hence, is monitored at the far field. The loss of this monitoring can lead to potentially hazardous conditions. An obstruction could exist between the localizer antenna and the far field monitor which would not be detected by the integral monitors or the near field monitors. Hence, to accomplish the primary purpose of the FMECA, the probability of external runway disturbances during the critical landing phase of a Category III landing must be known. However, the calculation of this probability requires a statistical analysis utilizing empirical data. Since such data is presently unavailable, a maximum allowable probability of occurance is established within the analysis of the FMECA and is listed as an assumption. The assumed value of this probability is  $1 \times 10^{-3}$ .

The proper alignment of the gliceslope antenna tower is vital for the radiation of correct signals. The alignment is monitored for permanent deformations due to such natural forces as earth a temors, strong winds, tower settling, etc. This probability of permanent misalignment (within the preventive maintenance cycle of a one week period) must be known for the accomplishment of the FMECA. Since such a probability is unavailable for this analysis, a maximum allowable value is again assumed. A maximum number for this occurrence is  $1x10^{-5}$ .

Coaxial cables, connectors, antennas and probes will not be treated independently for failure modes and effects, but rather are considered in the analysis as part of the functional block to which they are associated since the analysis is performed at the functional level.

The assignment of a criticality number to each failure mode is the conventional means of performing a criticality analysis. Such an approach, however, tends to be partially subjective due to weighing factors by which the criticality number is established. A more objective approach is: (1) to provide merely the failure rate as a representation of the criticality of each failure mode; and (2) to identify each failure mode as being either hazardous or not hazardous. These two items, moreover, are necessary inputs toward accomplishing the primary purpose of the FMECA as outlined in the procedure. For these reasons this approach will be utilized for the criticality analysis of the FMECA.

The failure rates used in this analysis were derived using the following considerations:

- a, Source of base failure rates was RADC Reliability Notebook, Volume II, dated September 1967. (RADC-TR-67-108)
- b. Equipment ambient temperatures was 25°C. Appropriate temperature rises were used for the part ambients depending upon their location in the equipment.
- c. Environmental factor was 'ground fixed' as defined in the RADC notebook.

## 6.0 FUNCTIONAL BLOCK DIAGRAMS

Appendices A and B contain detailed functional block diagrams of the localizer and glideslope respectively. It is at that functional level the FMECA will be performed. Also contained in the appendices are all the functional block diagrams of each major assembly. All the various functional block diagrams may be utilized to obtain a rather detailed understanding of system operation.

Two observations should be made concerning the general station block diagrams. First, all signals which can affect station operational performance are provided in the diagrams. Hence, only the outputs from each functional block need to be considered for analysis. Secondly, each functional block has an identification number by which the results of the tabulated analysis may be brought into system perspective. Additional clarification of the tabulated results of the FMECA can be attained when the functional block is viewed at the system level.

The detailed diagrams of the control unit for each station should be particularly useful for a thorough understanding of control unit operation. The Boolean expressions provided completely characterize all major logic signals and commands. Hence, these diagrams should be a tremendous aid in troubleshooting control unit failures.

#### 7.0 FAILURE ANALYSIS

The heart of the FMECA is the failure analysis. This analysis identifies each failure mode, describes the corresponding failure effects, and lists the failure rate by which its criticality is measured. This failure analysis is performed in the form given in figure 7-1. The following clarification of terms should be made concerning this form.

- 1. Failure Mode: This is the item (functional block) failure mode. Each failure mode reflects the piecepart failures within the block that can affect the output signals in the prescribed failure mode. Such terms as "loss of signal" are normally applied to any failure condition that totally destroys the characteristics of a "good" signal. Also any radiated signal that is not degraded beyond the Category III alarm limits is not considered to constitute a functional failure.
- 2. Failure Effect: Normally listed under this term are the immediate failure effects upon the system (or station) from an operational standpoint. Effects on radiated signals may also be listed here. Occasionally incorporated within this column are some conditional failure effect comments the effects upon the system operation if another failure were to occur.
- 3. System Operation After Failure: The system performance category immediately after the failure is revealed in these columns. These indications correspond to the performance indicator lamps at the Remote Control Tower. An "OFF" condition exists if the system is neither in Category II or Category III performance.
- 4. Failure Indications: The abnormal indication lights which should be lighted at the different locations after the failure occurs are presented in these columns. The Remote Control column lists the abnormal indications present at the Remote Control Tower. The Control Unit column is normally used to give the abnormal indications that are displayed on the respective station control unit front panel. The "other" column is normally utilized for any other display of abnormal indications such as the monitor channel alarm lights or the remote far field monitor indications. True monitor channel alarm light indications are revealed only in the monitors locally bypassed (MLB) mode of operation; hence, the monitor alarm light indications presented here are those that will be displayed in the MLB mode of operation. It should be

		<u> </u>	
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PAGE_OF_	AE.	5-6)	
PAG	FAILURE	X	
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Figure 7-1. Failure Analysis Form

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- realized that the MLB mode is utilized during any failure troubleshooting.
- Failure Rate: This column lists the total failure rate of the piecepart failures that can produce the respective functional failure mode. The failure rate given in this column is worst case since all component failure rates that can cause the particular failure mode are included regardless of the piecepart failure modes. In essence this number is a representation of the criticality of each failure mode - the larger the failure rate the greater the criticality of the failure mode. The failure rate number given in this column is in terms of failures per million hours. Failure rate identification is accomplished by alpha-numeric subscripts of \(\lambda\). The numeric portion of the subscript applies to the identification of the functional block; the alphabetic portion identifies the specific failure mode. For example, A1B implies the failure rate of the second (B) failure mode of the control unit (01).

The results of the failure analysis are provided in appendices C and D for localizer and glideslope respectively. The failure rates were determined on separate work sheets which will not be provided within this report. Table 7-1 provides an example of these work sheets, showing the failure rate calculations for two failure modes of the localizer control unit. All failure modes listed in the analysis are considered to be hazardous unless specifically identified to be "not hazardous" in the "remarks" column.

Table 7-1. Failure Mode Failure Ratz Calculations

System SSILS Subsystem LOCA-LIZER STATION

Identification	<u>"</u> ;}-					
I.D. Failure	<del>-</del>			, /#°cQ	Fâilure	Failure
			Assy/PWE	Component	$(\lambda_i \times 10^6)$	$\frac{\text{xare}}{(^{\lambda} \text{m x} \cdot 10^6)}$
01 Generation of an	Generation of an	٠.	Alarm PWB	U2 537051-1	+0.140	1.827
4	4			U4 537051-1	+0.140	
fer signal, due to	fer signal, due to			U6 537051-1	+0.140	-
alarm processing	alarm processing			U8 537051-1	+0.140	
circuitry.	circuitry.		· · ·	U13 537051-1	+0.140	
				U11 537051-1	+0,140	
				Uj6 537051-1	+0.140	
		, -		CR2 JANTXIN 4148	+0.041	
				CR4 JANTXIN 4148	+0.041	
			,	CR6 JANTXIN 4148	+0.041	
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		<del></del> .	CR8 JANTXIN 4148	+0.041	
			,	Subtotal	+1.144	
_			Alarm and	U12 537051-1	÷0.140	-
			time delay	U4 537051-1	+0.140	
			PWB.	U6 537051-1	+0.140	
			-	U8 537051-1	+0.140	
	~			CR 9 JANTXIN 4148	+0.041	2
				CR11 JANTXIN 4148	+0.041	
	-		!	CR13 JANTXIN 4148	+0.041	
				Subtotal	+0.683	3
		i	<.		Ų	-
						-
		-	_			_

Table 7-1. Fäilure Mode Failure Rate Calculations (Continued)

System SSILS Subsystem LOCALIZER STATION

						A Marie Control
Identification	ion				Failure	Failure
Item Name	I.D.	Failure	Assv/PWB	Part/	Rate	Rate
	No.	Mode		Camponent	("i x 10")	(wm × 10°)
Control	01	Generation of an	Alarm and	U2 53705.1≝มู	+0.140	3, 507
Unit	4	erroneous shut-	time delay	U13 537051≥1	+0.140	-
(Continued)		down signal due	PWB.	R25 2K	+0.006	
		to alarm proces-		B26 4.7K	+0.006	
		sing circuitry.		R27.0K	+0.006	
				R28 4.7K	+0.006	
			(	R29 2K	÷0.006	
		3		Q9 JANTX2N2907	+0.102	n
			•	O10 JANTX2N2222A	+0.058	
				CR3 JANTXIN 4148	+0.041	
	_			CR4 JANTXIN 4148	+0.041	-
				R32 10K	+0.006	
				R33 12K	+0.006	-
	١			R35 4.7k	+0.006	
				R36 10K	+0.006	
				QI'I JANTX2N 4858	+0.475	
				Q12 JANTX2N 2222A	+0.058	
				Subtotal	+1.109	
			Far field/	6.8K	+0,006	_
			shutdown	. 6802	÷0.006	
		,,,,	alert RWB.	22µf	+0.038	•
				JANTX2N 2222A	+0.058	
		ومندور ور		10K	+0.006	
				537051-1	+0.140	-
			,	Subtotal	+0.254	
	-				Ų	

Table 7-1. Failure Mode Failure Rate Calculations (Continued)

The ship with the second secon

System SSILS Subsystem LOCALIZER STATION

1				\$ 000	,	
Identification	ion	ş	:	-	Failure	Failüre
Item Name	i. D. No.	Failure Modë	Assy /{PWB	Part/ 	Rafe $(\lambda_{\parallel} \times 10^6)$	Rate ( <sup>A</sup> m × 10 <sup>6</sup> )
Control	10	Generation of an	Pwr/envir.	U5 537051-1	+0.140	<u>.</u>
Unit		erroneous shut-	PWB.	U3 537051-1	+0.140	<i>z</i> .
(Continued)		down signal due		Subtotal	+0.280	
		to alarm proces-	·	· ·		
		sing circuitry.	Alarm PWB	U11 537051-1	.0.140	•
		(Continued)		U16 537051-1	+0.140	
				U15 537051-1	+0.140	•
				ULZ \$37051-1	+0.140	
				Subtotal	40.560	-
			Control/inhi-	U8 537051-1	+0.140	,
7,1-1			bition PWB.	U\$ 537051-A	+0.140	
-	<b>(</b>	4	•	R6 1K	+0.006	
V	1			U12 537051-j	+0.140	
	L				÷0,140	,
7	<b>\</b> _			U2 537051-1	+0: 140	
	<u>.</u>			U1 537050-1	+0.140	
				U4 537051-1	+0.140	y
			7	R7 10K	+0.006	
	- 7		.,	R5 10K	+0.006	
				OI JANTX2N 2222A	+0.058	
				R39 IK	+0.006	_ <u>*</u> _
				Q11 JANTX2N 2222A	+0.058	
				U11 537051\L	+0,140	
				C11 22µf	+0.038	
				R38 4,7K	+0.006	de for
				Subtotal	+1.304	

#### 8.0 MATH MODELS

To fulfill the primary objective of this analysis, it must be verified that the probability of a potentially hazardous failure (a loss of signal or the radiation of a hazardous signal) during the critical landing phase be less than  $1 \times 10^{-7}$ . To achieve this verification, probability math models are utilized.

Figure 8-1 provides an illustration of a typical probability math model. As can be seen, three distinct paths lead to a failure. If the event whose probability is given by  $P_1$  occurs, a failure will result. For a failure to result due to path B events, all three events must occur, the probability of which is given by  $(P_2 \cdot P_3 \cdot P_4)$ . Path C is slightly more complicated. Either event 5 or event 6 must occur, event 7 must occur, and either event 8, 9, or 10 must occur to lead to a failure. Its probability of occurrance is given by  $[(P_5 + P_6) \cdot P_7 \cdot (P_8 + P_9 + P_{10})]$ . The overall total probability of a failure (P(F)) due to all three paths is simply the algebraic sum.

Rather than provide a graphical representation of the probability math models on the ILS system, it is decided to present only the probability equations of the math models. The graphical approach

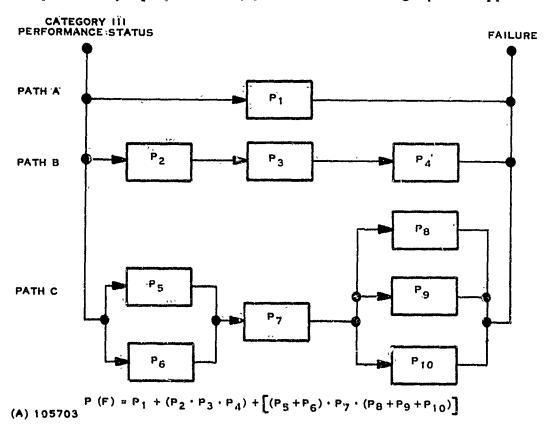


Figure 8-1. Example of the Graphical Representation of a Probability Math Model.

would be less than meaningful since adequate description of events could not be provided. The equations, of course, provide all the same information as the graphical representation. In addition, each path of failure can be treated independently by a separate probability equation and full description of probability, events can be provided.

All the math model equations for the localizer and glideslope are tabulated in appendices E and F respectively. Each contains two different sections - the "loss of signal" probabilities and the "hazardous signal radiation" probabilities. The probability expressions were formulated by considering each and every hazardous failure mode listed in the failure analysis. Like events (failure mode failure rates of similar failure effects) were grouped together whenever possible. For each separate probability expression listed, all failure modes in the failure analysis can be identified by failure rate subscripts. For some probability calculations, preventive maintenance cycles, which are listed in the "remarks" column, must be assumed. The reason for this is that a failure which does not cause a monitor alarm (a "hidden" failure) can only be located by periodic preventive maintenance procedures. Worst case probabilities are often given whenever the numerical result proves to be negligible. This is done solely for simplification purposes.

#### 9.0 PREVENTIVE MAINTENANCE

One of the secondary objectives of this analysis is to provide a commendation of how often preventive maintenance checks for hidden equipment failures should be performed to ensure a high-degree of system integrity. This is a natural output for the EMECA because preventive maintenance frequencies must be utilized in the math models.

To determine the frequency of preventive maintenance checks, two factors (or requirements) must be considered: (1) an allowable probability of failure occurrence; and (2) an allowable frequency of preventive maintenance so that total mean preventive maintenance time (MPMT) does not exceed equipment specification requirements. The recommended frequency then will be a suitable compromise between these two requirements. Whenever such a compromise cannot be attained (either or both requirements cannot be fulfilled), equipment design changes must be accomplished to reduce the probability of failure.

In practice, a reasonable frequency is an sumed in the math models and then the total MPMT is calculated to verify that the requirement is not exceeded. In assuming a preventive maintenance frequency, the time to perform the hidden failure check must also be considered. The charts showing the recommended preventive maintenance task frequencies for the localizer and glideslope are respectively given in appendices G and H. These charts incorporate the assumed frequencies utilized in the math model calculations. In addition to the hazardous failure modes considered in the math models; non-hazardous hidden failures identified in the failure analyses are also presented in the tables so that the overall MPMT can be calculated. A brief-description of the preventive maintenance task is also provided in the charts in order to estimate the time required to perform the hidden failure check. Whenever one check can be performed simultaneously with another, its estimated task time is omitted from the table.

The sole purpose of these charts is to provide a listing of the recommended frequencies of preventive maintenance checks for hidden failures and to show that these are consistent with preventive maintenance requirements. They are not intended to be used per se by field technicians. Preventive maintenance procedures that are to be used in the field should be much more detailed. However, the frequencies provided by these charts should be an input for writing the actual field procedures.

## 10.0 REMOTE CONTROL/STATUS DISPLAY

The status display unit is similar to the remote control unit except that it does not possess transmitter cycle capabilities and does not have a telephone. Hence, any analysis of the remote control unit services equally well for the status display unit. A simplified functional block diagram of the remote control unit is given in figure 10-1. As seen in the diagram, only one control signal for each station is an output from the unit. All other signals pertain to status only and as such cannot affect the actual radiated signal. The cycle control line failure mode is treated

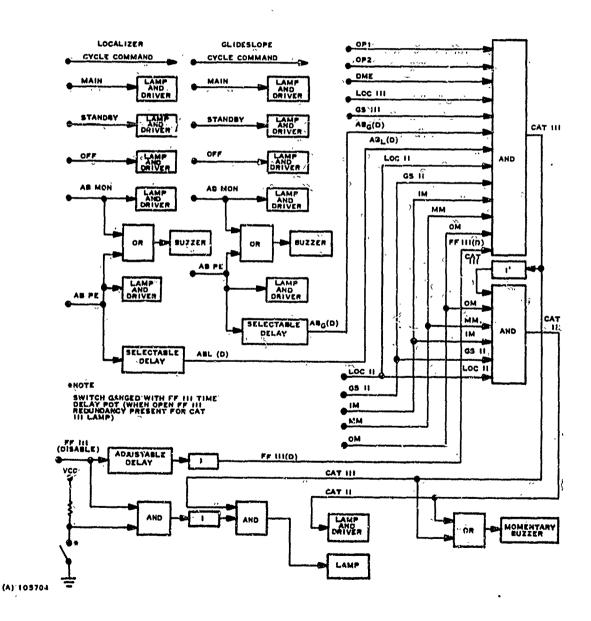


Figure 10-1. Remote Control Unit

within the framework of control unit failure modes for each station; hence, only an analysis of statics signals is necessary.

A détailed analysis of this unit is not necessary since the FMECA pertains only to a Category III performance status analysis. From an intuitive standpoint, only two revelant failure modes exist for the unit: (1) circuit failures causing the Category III performance lamp to be extinguished; and (2) circuit failures causing the Category III performance lamp to remain "on" continuously, regardless of station performance. The first of these failure modes is not hazardous. If an aircraft is just beginning (or already in) the critical landing phase, a safe Category III landing may be accomplished since the radiated signal is unaffected. Although station failures could conceiveably occur within that same 10 second critical landing phase period, the probability is totally negligible. The maximum probability of this event is given by the expression:

$$P_{\text{MAX}} = P_{\text{REQUIREMENT}} \cdot (\lambda_{\text{RC1}} \cdot 10 \text{sec})$$
  
where  $P_{\text{REQUIREMENT}} = 1 \times 10^{-7}$  (specified)

Control of the second of the s

and  $\lambda_{RCF}$  is the failure rate of the remote control unit circuitry that can cause the lamp to be extinguished.

To simplify matters, let  $\lambda_{RC1} = 100 \times 10^{-6}$  failures per hour as worst case. Then,

$$P_{MAX} = (T \times 10^{-7}) (100 \times 10^{-6}) (10/3600)$$
  
= 2.777 x 10<sup>-14</sup>

The second failure mode, circuit failures causing the Category III performance lamp to remain lit, is potentially hazardous since the "true" status of the radiated signal is not recognizable. However, if it is assumed that the operator check the transmitter status of each station prior to a Category III landing, the severity of the hazardous condition is greatly reduced. In face, the only potentially hazardous condition that then can exist is that the localizer signal be out of Category III tolerance at the far field. All other potentially hazardous conditions are recognizable through other status indications on the remote control unit. reason for this is that the far field Category III disable signal affects only category performance status. It is not processed by the localizer station and, hence, there is no redundant status display associated with it. The out-of-Category III-tolerance condition at the far field is due somety to external runway and overflight disturbances.

Since an initial evaluation of this potentially hazardous failure mode revealed its probability was too high, design changes were incorporated to provide redundancy and, thus, lower considerably the probability of this potentially hazardous occurrence. The new probability expression is given by:

$$P_{RC2} = (\lambda_{RC2} \cdot 168) (P_{FF_{CSE_{DDM}}}) \cdot (\lambda_{REDUND_{RC}} \cdot 168)$$

where  $\lambda_{RC2}$  = the failure rate of the remote control far field alarm processing circuitry which can cause the Category III performance lamp to remain illuminated, without redundancy.

REDUND RC = the failure rate of the redundancy circuitry that can cause the Category III performance lamp to remain illuminated.

FFCSEDDM = 10<sup>-3</sup> (assumed value) = the probability that the localizer ILS signal will be out of Category III DDM tolerance at the far field due to external runway distrubances during the critical landing phase of a Category III landing.

The calculated failure rate figures are given below:

$$\lambda_{RC2} = 1.141 \times 10^{-6}$$
 failures per hour

$$^{\lambda}_{REDUND_{RC}} = 0.268 \times 10^{-6}$$
 failures per hour

Hence, the new probability is:

$$P_{RC2} = (1.141 \times 10^{-6} \cdot 168) (10^{-3}) (0.268 \times 10^{-6} \cdot 168)$$
$$= 8.636 \times 10^{-12}$$

With the redundancy in the design incorporated, the probability of this potentially hazardous failure mode becomes negligible.

# 11.0 RESULTS/CONCLUSIONS

Overall failure probabilities are readily calculated from the math model tables by simple addition. Tables 11-1 and 11-2 enumerate the failure probabilities for the localizer and glideslope respectively. Table 11-3 provides a resultant failure probability summary. As can be seen, the overall probability of mission failure is 0.89345 x  $10^{-7}$  which is less than 1 x  $10^{-7}$ , the specified requirement. Hence, the primary purpose of this analysis has been accomplished.

Table 11-1. Total Localizer Hazardous Signal Probability

Α.	Loca	llizer Shutdown	Probabilities		
	1.	P <sub>S</sub> :	$3.912 \times 10^{-8}$	=	$39.120 \times 10^{-9}$
	2.	P <sub>AB</sub> :	3.516 x 10 -14	=	$0.000 \times 10^{-9}$
	3.	P <sub>AC</sub> ;	1.227 x 10 -11	=	$0.012 \times 10^{-9}$
		P <sub>AD</sub> :	$9.226 \times 10^{-13}$	=	$0.001 \times 10^{-9}$
		PSTBY CSE:	$1.722 \times 10^{-14}$	=	$0.000 \times 10^{-9}$
	6.	PSTBY SEN	$2.982 \times 10^{-15}$	=	0.000 x 10 <sup>-9</sup>
	7.	PSTBY CL:	$1.802 \times 10^{-14}$	=	$0.000 \times 10^{-9}$
	8.	PSTBY ID:	$1.665 \times 10^{-16}$	2	$0.000 \times 10^{-9}$
		P <sub>STBY</sub> :	$9.837 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
		PPS/CONV;	$9.906 \times 10^{-11}$	=	$0.099 \times 10^{-9}$
		P <sub>CSE/ID</sub> :	5.106 x 10.10	=	$0.511 \times 10^{-9}$
		P <sub>SEN</sub> :	$2.090 \times 10^{-10}$	=	$0.209 \times 10^{-9}$
	13.	P <sub>CL</sub> :	4.540 $\times$ 10 <sup>-10</sup>	=	$0.454 \times 10^{-9}$
	14.	P <sub>NF</sub> :	$1.422 \times 10^{-10}$	=	$0.142 \times 10^{-9}$
		P <sub>FF</sub> :	$6.081 \times 10^{-10}$	=	$0.608 \times 10^{-9}$
	16.	PINHIB.	6.822 x 10 <sup>-9</sup>	=	$6.822 \times 10^{-9}$
			$P_{SD} = \Sigma A$	=	$47.978 \times 10^{-9}$

Table 11-1. Total Localizer Hazardous Signal Probability (continued)

В.		lizer Hazardous S		Pr	obabilities
	1.	P(HS) CSE DDM	$1.287 \times 10^{-15}$	=	0.000 x 10 <sup>-9</sup>
	2,	P(HS) rr:	$5.555 \times 10^{-10}$	=	-,,
	3.	P(HS) CSE DDM:	$4.971 \times 10^{-10}$	Ę	
	4.	P(HS) CSERF:	$1.502 \times 10^{\circ}$	=	
	5.	P(HS) <sub>SEN</sub> :	$1.354 \times 10^{-10}$	=	0.135 x 10 <sup>-9</sup>
	6.	P(HS) CL DDM:	$3.584 \times 10^{-9}$	=	$3.584 \times 10^{-9}$
	.,		P <sub>HS</sub> = ΣB	=	$6.274 \times 10^{-9}$
	PTOT	TAL LOCALIZER	P <sub>SD</sub> + P <sub>HS</sub>	=	54. 252 x 10 <sup>-9</sup>
		LOCALIZER		=	$0.54252 \times 10^{-7}$

Table 11-2. Total Glideslope Hazardous Signal Probability

	Table	e 11-2. Total G	lideslope Hazardo	ous S	Signal Probability
Α.	Glide	slope Shutdown			
	1.	P <sub>S</sub> :	$2.197 \times 10^{-8}$	=	$21.970 \times 10^{-9}$
	2.	P <sub>AB</sub> :	$2.691 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
		P <sub>AC</sub> :	$5.884 \times 10^{-12}$	=	0.006 x 10 <sup>-9</sup>
		P <sub>AD</sub> :	1.503 x 10 <sup>-15</sup>	=	$0.000 \times 10^{-9}$
		PSTBY CSE:	$9.045 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
		PSTBY SEN:	1.648 x 10 <sup>-15</sup>	=	$0.000 \times 10^{-9}$
		PSTBY CL:	$2.282 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
		P <sub>STBY</sub> :	$2.314 \times 10^{-15}$	=	$0.000 \times 10^{-9}$
		P <sub>CONV</sub> :	$1.814 \times 10^{-13}$	=	$0.000 \times 10^{-9}$
		P <sub>CSE</sub> :	1.815 x 10 <sup>-10</sup>	=	$0.182 \times 10^{-9}$
		P <sub>SEN</sub> :	$1.035 \times 10^{-10}$	=	0.104 x 10 <sup>-9</sup>
		P <sub>CL</sub> :	$1.908 \times 10^{-10}$	=	$0.191 \times 10^{-9}$
	13.	P <sub>NF</sub> :	1.403 x 10 <sup>-10</sup>	=	$0.140 \times 10^{-9}$
	14.	P <sub>INHIB</sub> :	$3.411 \times 10^{-9}$	<b>*</b>	$3.411 \times 10^{-9}$
			$P_{SD} = \Sigma A$	=	26.044 x 10 <sup>-9</sup>

Table 11-2. Total Glideslope Hazardous Signal Probability (continued)

			,		<u> </u>	
<u>3.</u>		slope Ĥazardous			Prob	
`,	1.	P(HS) CSE ĎDM	(8: 989	× 10 <sup>-16</sup>	=	$0.000 \times 10^{-9}$
	2.	P(HS) CSE SDM:	4.558	x 1'0	=	0.456 x 10 <sup>-9</sup>
	3.	P(HS) CSE PE:	1.248	x 10 ′	=	$1.248 \times 10^{-9}$
	4.	P(HS) GEN:	1.518	x 40 10	=	$0.152 \times 10^{-9}$
	5.	P(HS)CL:	4.427	x 10 <sup>-9</sup>	·=	1.427 $\times$ 10 <sup>-9</sup>
		P(HS) <sub>ATM</sub> :	·5. 806	$\times 10^{-9}$	÷	$5.806 \times 10^{-9}$
	_	AT W	:	P <sub>HS</sub> = ΣB	=	9.089 x 10 <sup>-9</sup>
~	PTC	)TA1	= P <sub>c</sub>	SD + PHS	=	35. 110 x 10 <sup>-9</sup>
	10	OTAL GLIDESLOF	E .	D Ho		$.35110 \times 10^{-7}$

Table 11-3. Probability Summary

<u>A.</u>	Local			•
	(4)	Shutdown (Loss of Radiated Sig	nal):	$47.978 \times 10^{-9}$
	(2)	Radiation of Hazardous Signal	:	$6.274 \times 10^{-9}$
В.	Glide	slope:		
	(1)	Shutdown (Loss of Radiated Sig	nal):	$26.004 \times 10^{-9}$
	(2)	Radiation of Hazardous Signal	.;	9.089 x 10 <sup>-9</sup>
<u>c.</u>	Total	_		89.345 x 10 <sup>-9</sup>
•			or	$0.89345 \times 10^{-7}$

To achieve this primary objective, however, circuit design changes/modifications as dictated by the FMECA had to be accomplished. The following is a listing of these changes/modifications.

1. The SDM strap option will be employed for the localizer near field and far field monitor channels. The SDM alarm limits, however, will not be to Category III limits, but rather to some less stringent value which will provide an alarm output when a total loss of input signal exists. The SDM and DDM alarms will be "or'd" internal to the monitor channel, thus providing one general alarm output for alarm processing in the control

unit. The SDM strap option will also be utilized for the glideslope near field monitor channels.

- 2. If a continuous main monitor inhibit is generated in the control unit, a downgrading of category status indication (neither Category III or II) will occur at the remote control unit. In this way total loss of all monitoring due to inhibit circuitry failures will be remotely recognizable.
- 3. Additional redundancy in the far field monitor combining logic has been employed to reduce the probability of the loss of the far field Category III monitoring capability.
- 4. Redundancy circuitry has been incorporated in the control unit to provide direct remote status indication (performance category downgrade) whenever a "transfer condition" exists. This redundancy significantly reduces the probability of radiating a hazardous signal due to control unit processing circuit failures.
- 5. Redundancy has been employed in the remote control/ status displays units to extinguish the Category III performance light whenever a far field Category III disable signal occurs.
- 6. An antenna misalignment detector test feature has been incorporated into the design to allow for a "quick and easy" check of its integrity. This was required to comply with preventive maintenance requirements.

To confirm that the preventive maintenance frequencies assumed within this analysis are consistent with the requirements, a quick comparison of the assignments made in appendices G and H with the equipment specification is in order. The equipment specification states that a mean preventive maintenance time (MPMT) of one hour in 336 hours of equipment operation for any station is allowable. The total MPMT estimated for localizer hidden failures is 21.9 minutes in 336 hours of equipment operation; the total MPMT for the glideslope hidden failures is 14.0 minutes in 336 hours of equipment operation.

As another outgrowth of the FMECA the following general discussion on redundancy has evolved:

e In the general design of electronic equipment, standard design procedures such as use of high reliability parts and minimization of circuit components do not necessarily ensure that system design is optimum from a performance standpoint. To obtain a high degree of system perfor-

mance, redundancy of equipment hardware has often been employed in design. This is a very effective means when utilized correctly. Unfortunately the full advanages of redundancy are often overlooked.

To exhibit the optimum use of redundancy in equipment design, the examples of figures 11-1 and 11-2 are provided. Assume that each of the monitor channels monitors the same system parameter. Triplicate redundancy has been incorporated in the monitoring circuitry, requiring a 2 of 3 vote for monitor alarm processing in the control logic. Figure 11-1 illustrates the typical approach (minimum circuit complexity) utilized in circuit design (redundant control logic excluded). However, when calculating the probability of loss of the parameter monitoring ability (P(F)<sub>NR</sub>), an interesting observation results. The desirable features of triplicate monitoring are partially lost due to the control logic and "OR" gate (PCL and POR respectively). It is these circuit components that limit the reduction of the probability of failure. Hence, all the additional circuitry incorporated for triplicate monitoring is rendered partially useless in minimizing the probability of failure.

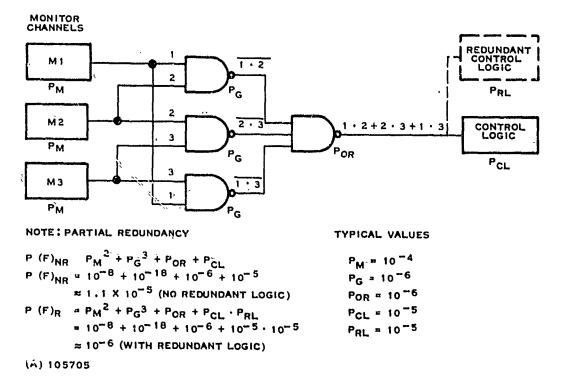
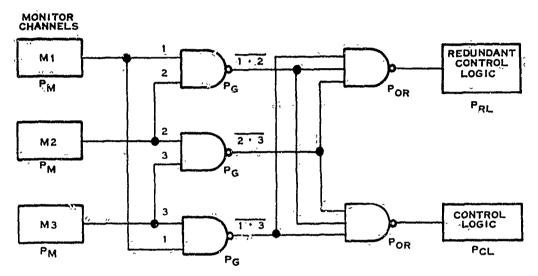


Figure 11-1. Logic Illustrating 2 of 3 Vote of Monitors for Control Processing (dashed lines illustrates partial redundancy).

An improvement of the original design results with the additional redundant control logic (dashed lines). The new probability (P(F)<sub>R</sub>) calculation shows that there is roughly an improvement by one order of magnitude, utilizing typical values. However, as the new calculation illustrates, the true advantageous features of triplicate monitoring are still not attained. A "bottle-neck" limiting factor is still present - the "OR" gate (POR).



P (F)<sub>RCP</sub> = 
$$P_M^2 + P_G^3 + P_{OR}^2 + P_{CL} \cdot P_{RL}$$
  
=  $10^{-8} + 10^{-18} + 10^{-12} + 10^{-5} \cdot 10^{-5}$   
=  $10^{-8}$  (WITH\*OPTIMUM REDUNDANCY)

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- Ligure 11-2. Logic Illustrating 2 of 3 Vote of Monitors for Control Processing with Optimum Redundancy
  - Figure 11-2 is an illustration of the optimum design, utilizing redundancy. With the additional "OR" gate included, the full advantages of redundancy are attained since the limiting factor is now the monitor channels. One final observation should be pointed out concerning this matter the addition of a single redundant gate has decreased the probability of failure two orders of magnitude, utilizing typical values. In summary then, it is vitally important to incorporate redundancy correctly if redundancy is to be incorporated at all.

The following enumerates the general conclusions resulting from the FMECA:

- 1. If the assumptions made within this analysis prove to be reasonably valid, the probability of either (1) a loss of signal or (2) the radiation of a potentially hazardous signal during the critical landing phase of a Category III landing is less than 1 x 10<sup>-7</sup> for Texas Instruments Incorporated Category III ILS system. The validity of the result of the overall hazardous failure probability is enhanced since worst case analysis were often employed.
- 2. Single equipment failures which can lead directly to station shutdown are the major contributors which limit the reduction of the probability of a hazardous failure. Hence, to achieve further improvement of equipment design and reliability, additional redundancy in major non-redundant circuits such as the control unit is required.
- 3. Due particularly to the redundancy that has been incorporated into the design as a result of the FMECA, the probability of the radiation of a potentially hazardous signal has become insignificant compared to shutdown probabilities. The design modifications have made the triplicate monitoring utilized in the Category III system optimum since the "bottleneck" factor is the monitor channels themselves.
- 4. Since all hidden failure modes are identified in the FMECA, the results of the analysis serve as an excellent input for the writing of preventive maintenance procedures. The frequencies of these preventive maintenance checks stratified within this report are based upon allowable probabilities of occurrence and, hence, should be followed very closely in field performance.
- 5. Troubleshooting system failures should be greatly facilitated by utilizing both the functional block diagrams and the failure mode and effects analysis data.

### 12.0 REFERENCES

The references used in development of this analysis are listed below:

"Aerospace Recommended Practice 926", Society of Automotive Engineers, Inc., New York, New York, September 15, 1967.

"Annex 10 - Aeronautical Telecommunications, Volume I", International Civil Aviation Organization, 2nd Edition, April 1968.

"RADC Reliability Notebook, Volume II", Technical Report No. RADC-TR-67-108, September 1967.

"Reliability Engineering", ARING Research Corporation, Prentice Hall, 1964.

"Reliability Requirements for Safe All Weather Landings"; Adkins, L. A.; Thatro, M. C.; Proceedings of the 7th Reliability and Maintainability Conference, San Francisco, California, July 14-17, 1968.

Appendix A

Localizer Detailed Functional Block Diagrams

# Appendix A

# Localizer Detailed Functional Block Diagrams

This appendix consists of detailed functional block diagrams for the localizer. Figures A-4 through A-19 cover the numbered blocks in figures A-1 and A-2 (localizer and localizer far field monitor). Figure A-3 and the accompanying table A-1 detail the localizer control unit.

Table A-1. Definition of Signal Names (Localizer Control Unit, Figure A-3)

Name	<b>Definition</b>
A <sub>BAT</sub> :	Alarm due to a drop in the main battery voltage.
A <sub>CON</sub> V;	Alarmon one of the DC/DC converter voltages.
A <sub>FE</sub> :	Far field shutdown alarm.
A <sub>PE</sub> :	Power/environmental alarm sent to remote control.
A <sub>S</sub> :	Alarm due to standby monitors.
A <sub>S(D)</sub> :	Alarm due to standby monitors, delayed.
A <sub>SM</sub> :	Alarm due to standby monitors, memorized.
AB:	Abnormal condition signal.
AB <sub>MON</sub> :	Abnormal condition signal due to monitor channel alarm.
ABMON <sub>RC</sub> :	Monitor alarm sent to remote control.
AC:	AC power alarm from one of the two battery chargers.
BC:	Battery charger alarm from one of the two chargers.
BLINK:	Blinker output signal, a square wave oscillator.
C:	Cycling command signal for transmitters.
C <sub>ANT</sub> :	Command to have transmitter no. 1 connected to the antenna.
₹ANT:	Command to have transmitter no. 2 connected to the antenna.
c <sub>1</sub> :	Command to turn on transmitter no. 1.
c <sub>2</sub> :	Command to turn on transmitter no. 2.
CAT II <sub>RC</sub> :	Signal to remote control used to determine Category II status.
CAT III <sub>RC</sub> :	Signal to remote control used to determine Category III status.

Table A-1. Definition of Signal Names (Localizer Control Unit, Figure A-3) (Continued)

Name	Definition
CONTROL:	Cycle command (MAIN, STBY, or CFF).
CL <sub>11</sub> :	Category III DDM clearance alarm, monitor no. 1.
CL <sub>12</sub> :	Category III DDM clearance alarm, monitor no. 2.
CL <sub>13</sub> :	Category III DDM clearance alarm, monitor no. 3.
CL <sub>21</sub> :	Category III SDM clearance alarm, monitor no. 1.
ĈГ	Category III SDM clearance alarm, monitor no. 2.
CL <sub>23</sub> :	Category III SDM clearance alarm, monitor no. 3.
CL <sub>31</sub> :	Category III RF clearance alarm, monitor no. 1.
CL <sub>32</sub> ;	Category III RF clearance alarm, monitor no. 2.
CL <sub>33</sub> :	Category III RF clearance alarm, monitor no. 3.
CSE <sub>11</sub> :	Category III DDM course alarm, monitor no. 1.
CSE <sub>12</sub> :	Category III DDM course alarm, monitor no. 2.
CSE <sub>13</sub> :	Category HI DDM course alarm, monitor no. 3.
CSE <sub>21</sub> :	Category III SDM course alarm, monitor no. 1.
CSE <sub>22</sub> :	Category III SDM course alarm, monitor no. 2.
CSE <sub>23</sub> :	Category III SDM course alarm, monitor no. 3.
CSE <sub>31</sub> :	Category III RF course alarm, monitor no. 1.
CSE <sub>32</sub> :	Category III RF course alarm, monitor no. 2.
CSE <sub>33</sub> :	Category III RF course alarm, monitor no. 3.
CSE 111:	Category II DDM course alarm, monitor no. 1.
CSE 112:	Category II DDM course alarm, monitor no. 2.
CSE 113:	Category II DDM course alarm, monitor no. 3.

\*;\*

Table A-1. Définition of Signal Names (Localizer Control Unit, Figure A-3) (Continued)

Name	Definition
FF <sub>BY</sub> :	Far field bypass local.
FFBYR:	Far field bypass remote.
FF <sub>MM</sub> :	Far field mismatch.
FF <sub>PE</sub> :	Far field power/environmental alarm.
FF <sub>S</sub> :	Far field shutdown.
FF <sub>SA</sub> :	Far field shutdown alert.
<sub>4</sub> C;	Inhibit signal to inhibit transmitter cycling capability.
I <sub>MAIN</sub> :	Main inhibit to main monitor channels.
I <sub>ON</sub> :	Inhibit signal due to power turn-on.
ľ <sub>T</sub> :	Inhibit signal due to transfer commands, either auto or manual.
I <sub>g</sub> :	Inhibit signal due to shutdown commands, either auto or manual,
I <sub>STBY</sub> :	Standby inhibit to standby monitor channels.
ID No. 1 (tone):	ID tone from ID unit no. 1.
ID No. 2 (tone):	ID tone from ID unit no. 2.
L <sub>AB</sub> :	Abnormal status lamp signal.
J.AC:	AC power alarm status lamp signal.
L <sub>BAT</sub> :	Battery alarm status lamp signal.
L <sub>BC</sub> :	Battery charger alarm status lamp signal.
r <sup>C</sup> :	DC/DC converter alarm status lamp signal.
L <sub>FFBY</sub> :	Far field bypass status lamp signal.

Table A-1. Definition of Signal Names (Localizer Control Unit, Figure A-3) (Continued):

Name	Definition
L <sub>FF</sub> GO	Far field "good condition" status lamp signal.
L <sub>FF</sub> MM	Far field monitor mismatch status lamp signal.
L <sub>FF</sub> :	Far field power/environmental status lamp signal.
L <sub>FE</sub> :	Far field shutdown status lamp signal.
L <sub>N</sub> :	Normal status lamp signal.
L <sub>TEMP</sub> :	Temperature alarm status lamp signal.
L <sub>MLB</sub> :	Monitors locally bypassed status lamp signal.
L <sub>MM</sub> :	Monitor mismatch status lamp signal.
L <sub>S</sub> :	Shutdown status lamp signal.
Lx1:	Transmitter no. 1 connected to antenna status lamp signal.
L <sub>X2</sub> :	Transmitter no. 2 connected to antenna status lamp signal.
LOC:	Local control of transmitting unit.
LT:	Transfer signal memorized.
MA <sub>CL</sub> :	Clearance monitor alarm.
MACSE <sub>111</sub> :	Course monitor alarm, Category II alarm limits.
MA <sub>CSE111</sub> :	Course monitor alarm, Category III alarm limits.
MA <sub>ID</sub> :	Monitor alarm, 2 of 3 ID monitors.
MA <sub>NF(D)</sub> :	Near field monitor alarm which is delayed.
MA <sub>S</sub> :	Shutdown command from monitor alarms.

Table A-1. Definition of Signal Names (Localizer Control Unit, Figure A-3) (Continued)

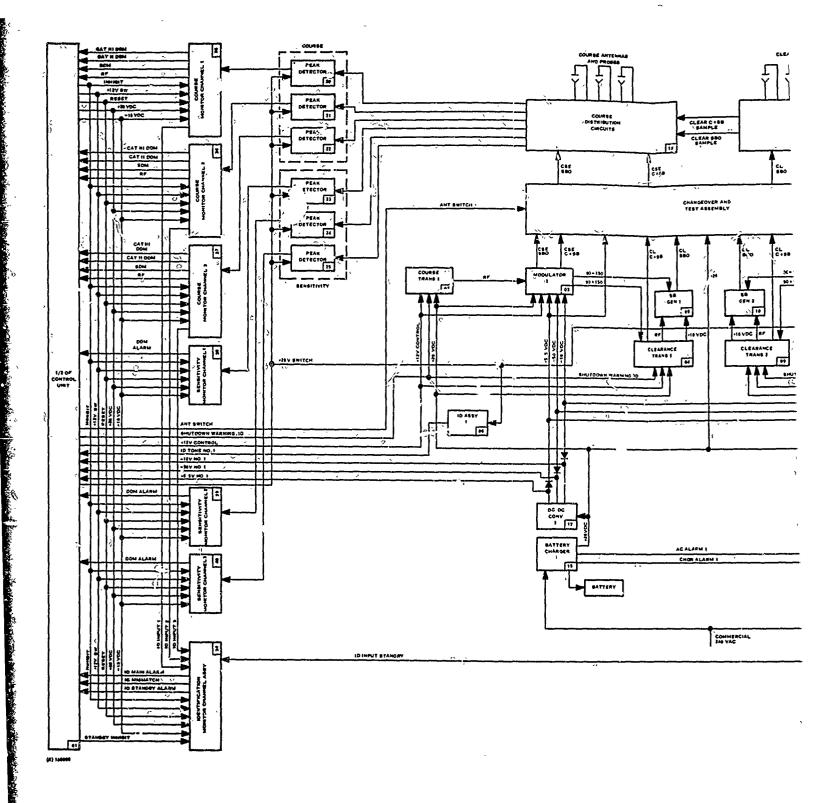
Name	Definition
MA <sub>SEN</sub> :	Sensitivity monitor alarm.
MA <sub>T</sub> :	Transfer command from monitor alarms.
MAIN:	Main transmitter "on" status signal.
MAIN <sub>RC</sub> :	Signal to remote control used to determine MAIN status.
MLB:	Monitors locally bypassed.
MM <sub>CL</sub> :	Clearance monitor mismatch.
MM <sub>CL/NF</sub> :	Clearance or near field monitor mismatch.
MMCSE <sub>111</sub> :	Course monitor mismatch, Category III alarm limits.
MM <sub>FF</sub> :	Far field monitor mismatch.
MM <sub>1D</sub> :	Monitor mismatch, 1 of 3 I D monitors.
MM <sub>NF(D)</sub> :	Near field monitor mismatch which is delayed.
MM <sub>SEN</sub> :	Sensitivity monitor mismatch, Category III alarm limits.
NF 1:	Category II DDM near field alarm, monitor no. 1.
NF 2:	Category II DDM: mear field alarm, monitor no. 2.
OFF:	Both transmitters "off" status signal.
OFF <sub>RC</sub> :	Signal to remote control used to determine OFF status.
ON/OFF:	Front panel control unit power supply control.
REM:	Remote control of transmitting unit.
RESET:	Signal to reset alarm memory latches.
SCT:	Standby clearance monitor alarm - DDM, SDM or RF with Category III limits.
S <sub>CSE</sub> :	Standby course monitor alarm - DDM, SDM, or RF with Category III limits.

Table A-1. Definition of Signal Names (Localizer Control Unit, Figure A-3) (Continued)

Name	Definition
Ś <sub>ID</sub> :	Standby identification monitor alarm - Category III limits.
s <sub>M</sub> :	Shutdown signal memorized.
s <sub>SEN</sub> :	Standby sensitivity monitor alarm - DDM with Category III limits.
s <sub>o</sub> :	Both transmitter are selected to be off.
s <sub>1</sub> :	Transmitter no. 1 is selected as main.
s <sub>2</sub> :	Transmitter no. 2 is selected as main.
<u>s</u> 12:	Selection of transmitter no. 1 memorized.
s <sub>12</sub> :	Selection of transmitter no. 2 memorized.
SA <sub>NF</sub> :	Shutdown alert signal due to near field monitors.
SEN <sub>ll</sub> :	Category III DDM sensitivity alarm, monitor no. 1.
SEN <sub>12</sub> :	Category III DDM sensitivity alarm, monitor no. 2.
SEN <sub>13</sub> :	Category III DDM sensitivity alarm, monitor no. 3.
STBY:	Standby transmitter "on" status signal.
STBY RC:	Signal to remote control used to determine STAND-BY status.
TEMP:	Temperature alarm inside main cabinet.
XFR:	Transfer command due to XFR1 or XFR2 (redundant for remote recognition).
XFR1:	Transfer command due to course and sensitivity (redundant).
XFR2:	Transfer command due to clearance and near field (redundant).
XMTR No. 1 (shutdown warn-ing/ID no. 1):	Sum of shutdown alert and 1D tone no. 1.

Table A-I. Definition of Signal Names (Localizer Control Unit, Figure A-3) (Continued)

Namé	Definition			
XMTR No. 2 (shutdown warns ing/ID no. 2):	Sum of shutdown alert and ID tone no. 2:			
+12V ĈÓNÍROL:	control signal to turn on rhonitor channels.			
-18V:	A common -18v from the two DC/DC converters.			
-181:	-18 volts from converter no. 1.			
÷18 <sub>2</sub> :	-18 volts from converter no. 2.			
+28V BATŢ:	The voltage of the main batteries.			
+5,1:	+5 volts from converter no. 1.			
+5 <sub>2</sub> :	+5 volts from converter no. 2.			
-50 <sub>1</sub> :	-50 volts from converter no. 1.			
-50 <sub>2</sub> :	-50 volts from converter no. 2.			
	!			





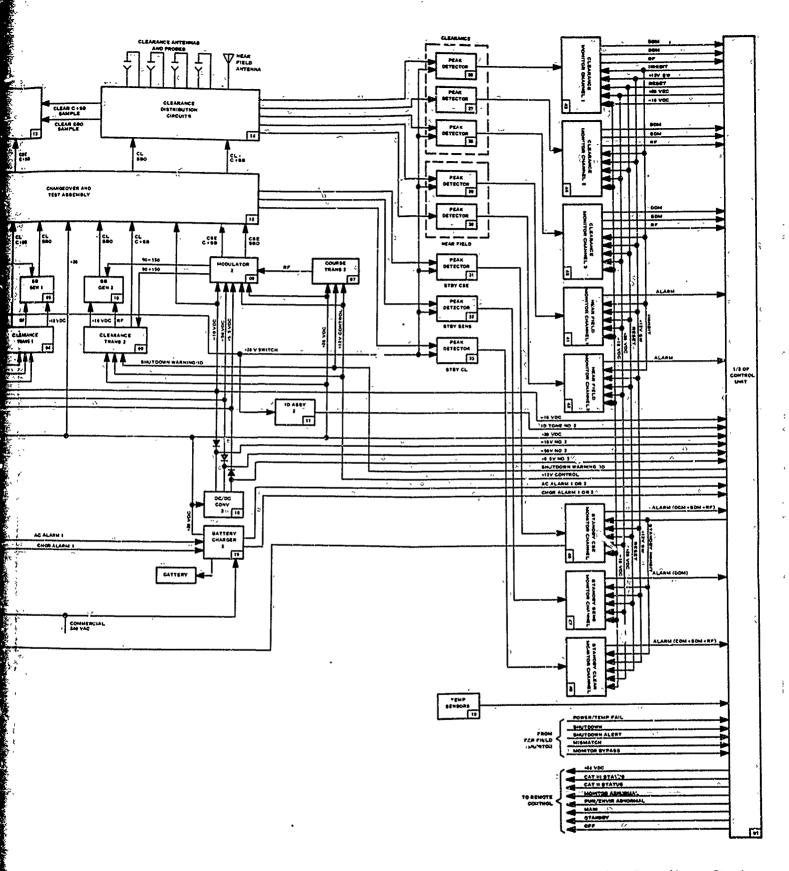
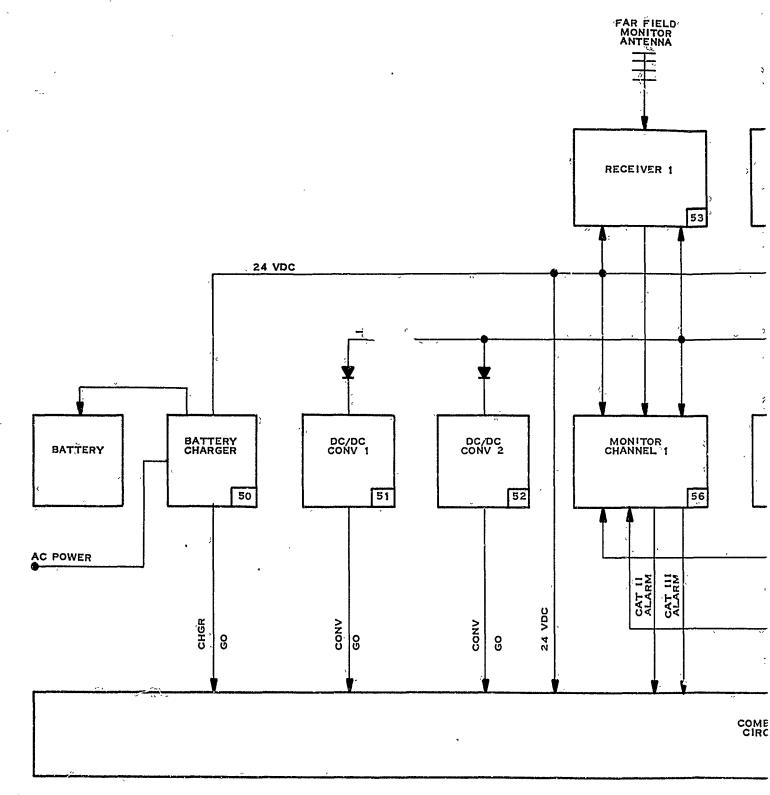


Figure A-1. Localizer Station

A-9/A-10



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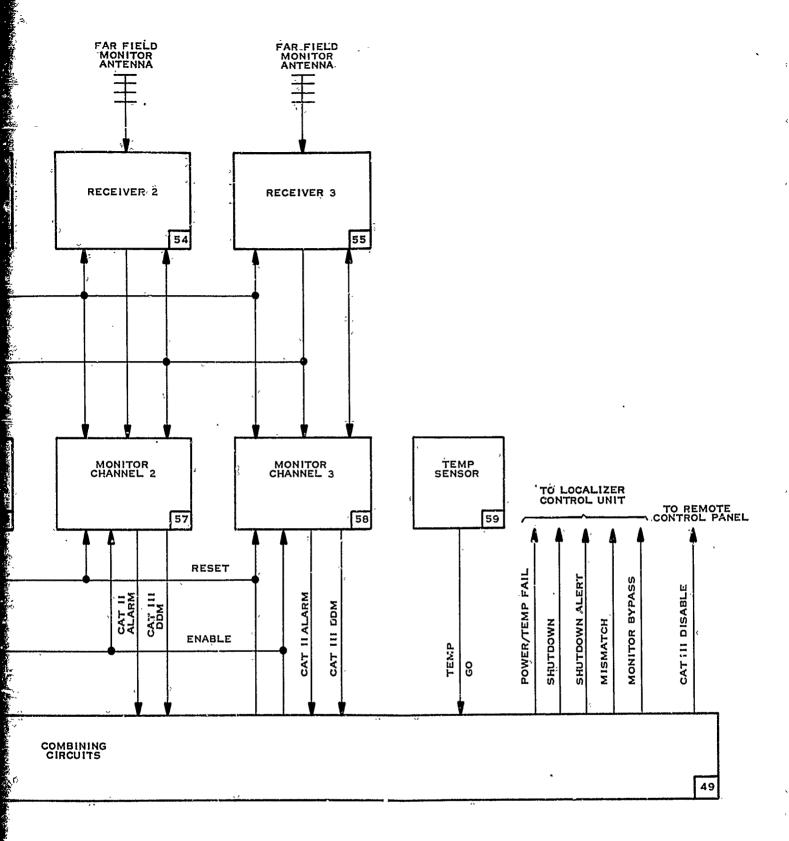
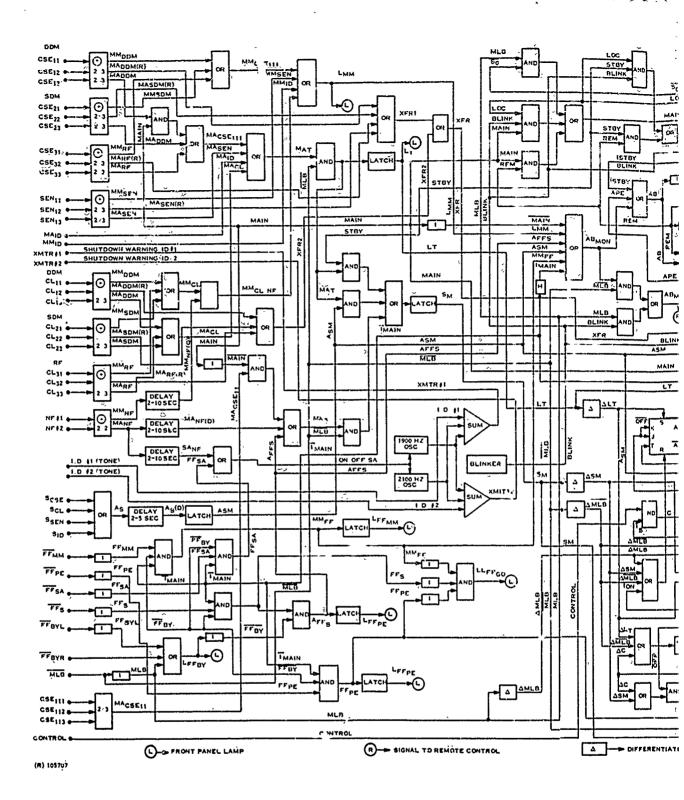


Figure A-2. Far Field Monitor

A-11/A-12





A

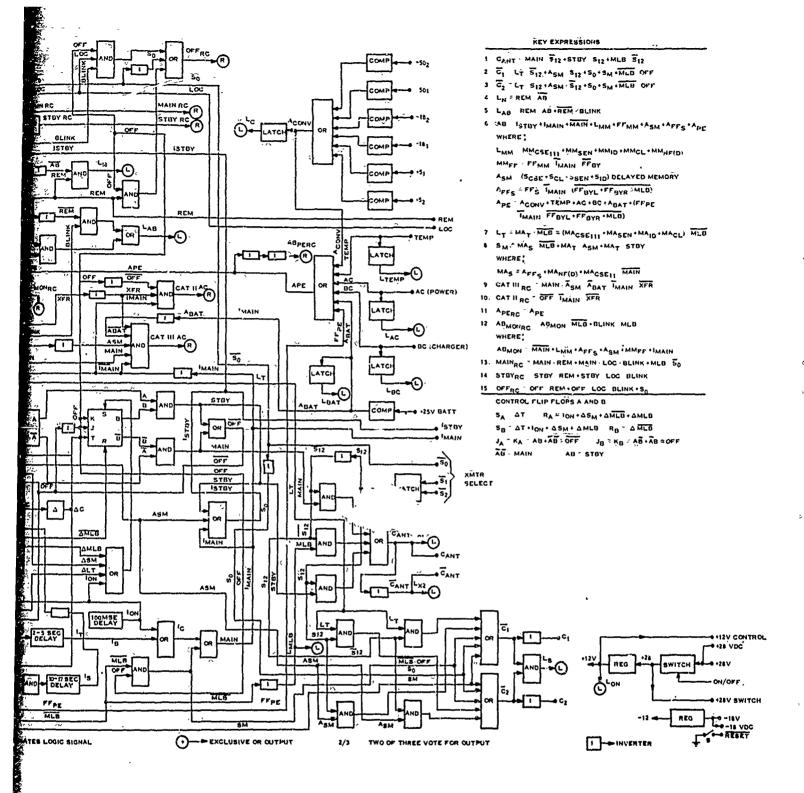


Figure A-3. Localizer Control Unit

A-13/A-14



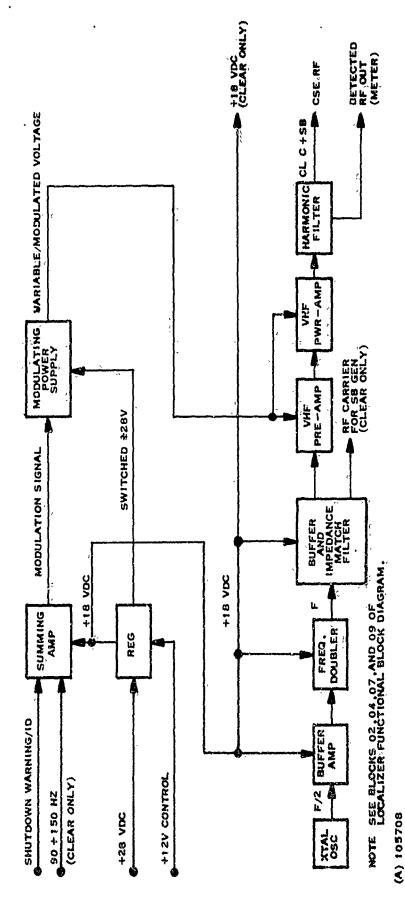
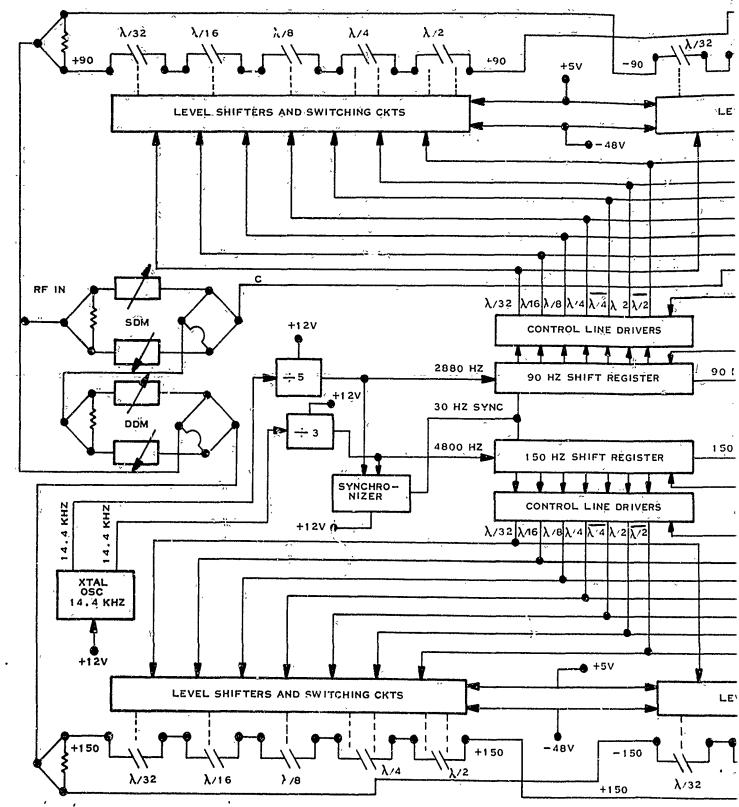


Figure A-4. VHF Transmitter (Course and Clearance)



NOTE: SEE BLOCK 03 AND 08 OF LOCALIZER FUNCTIONAL BLOCK DIAGRAM.

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TEST CKT (150)

λ/2

λ/32

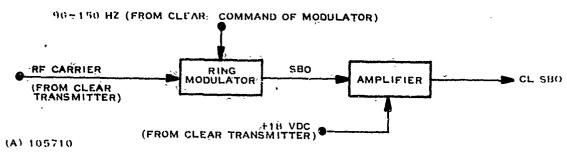
λ/8

λ/16

λ/4

Figure A-5. VHF Modulator

A-17/A-18



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NOTE: SEE BLOCKS 05 AND 10.0F LOCALIZER' FUNCTIONAL BLOCK DIAGRAM.

Figure A-6. Sideband Generator

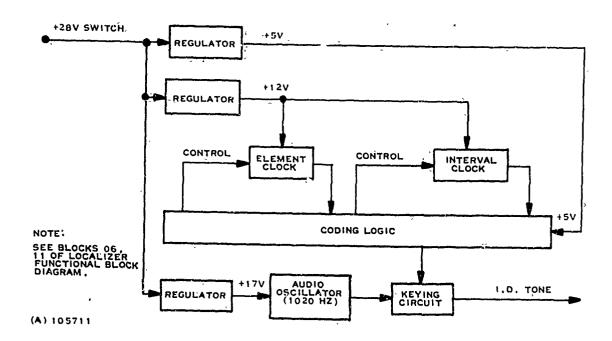


Figure A-7. Identification Unit

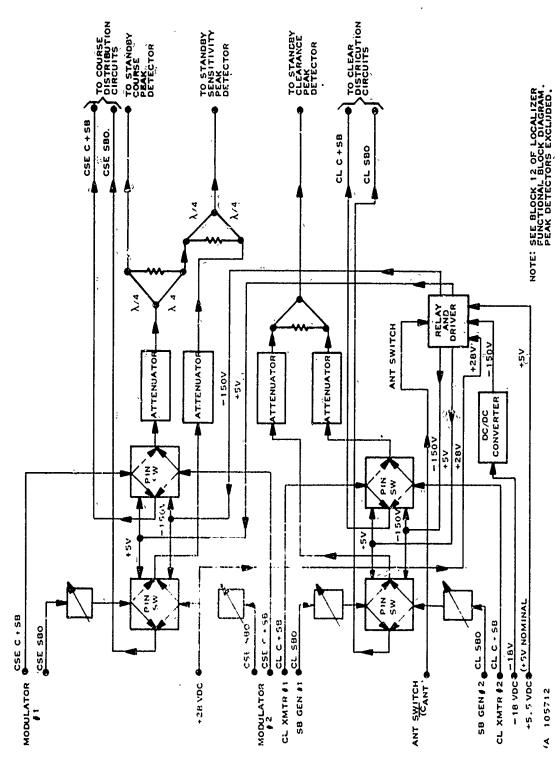
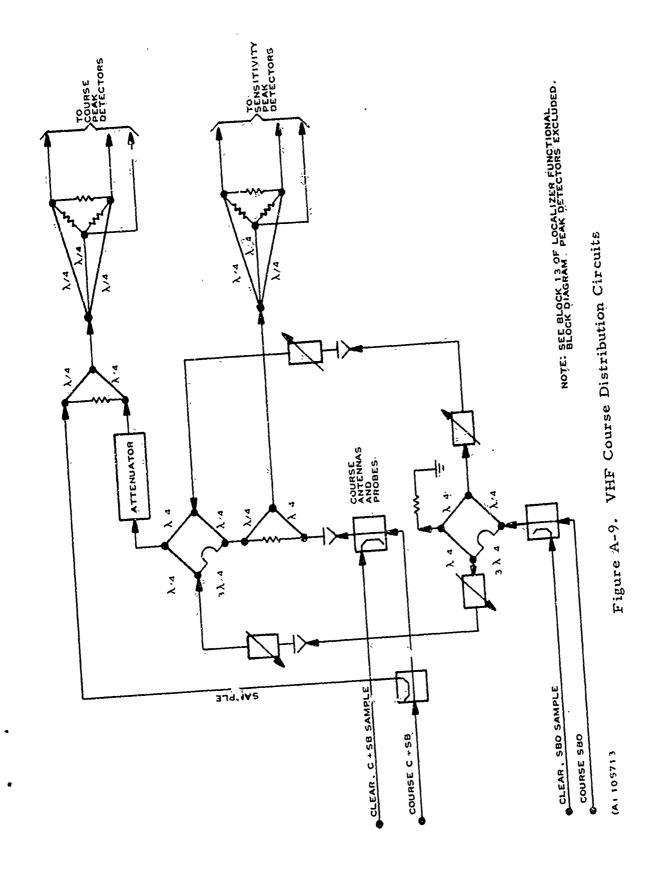
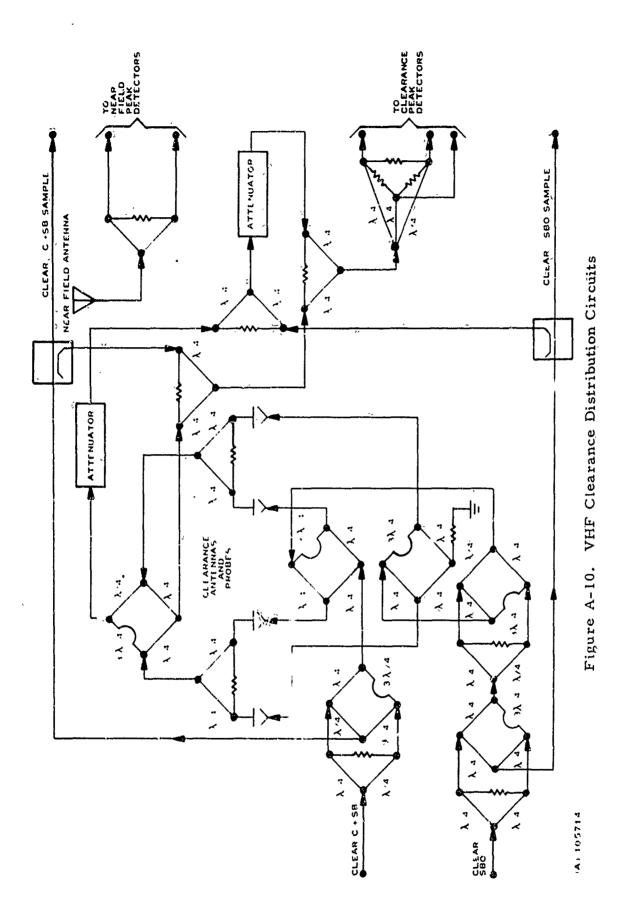
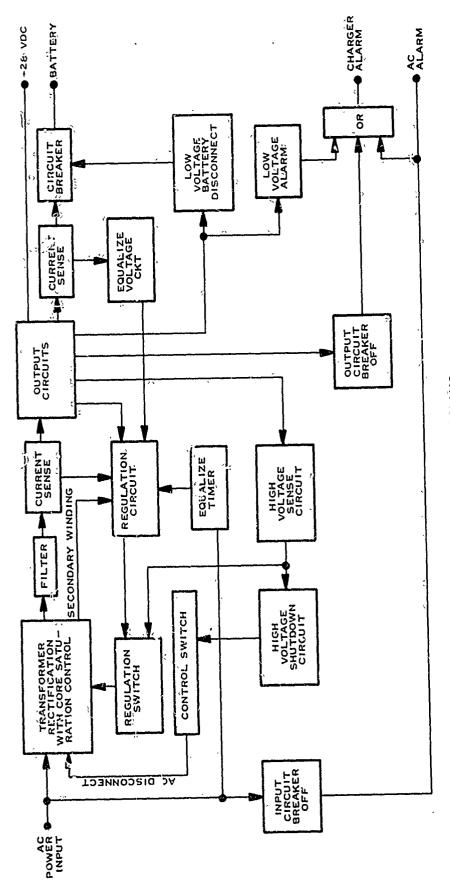


Figure A-8. VHF Changeover and Test Assembly





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\*CHARGER ALARM" AND "AC ALARM" ARE OPEN RELAY CONTACTS IN THE ALARM STATE, CLOSED NORMALLY. THE CORRESPONDING ALARMS FROM BOTH CHARGERS ARE WIRED IN SERIES. NOTE: SEE BLOCKS 15 AND 16 OF LOCALIZER FUNCTIONAL BLOCK DIAGRAMS.

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Figure A-11. Battery Charger

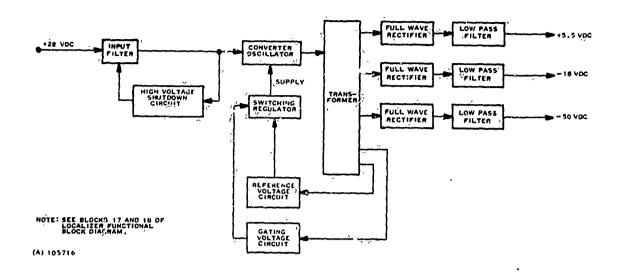


Figure A-12. Dc/Dc Converter

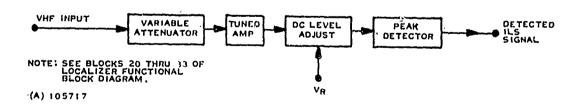


Figure A-13. VHF Peak Detectors

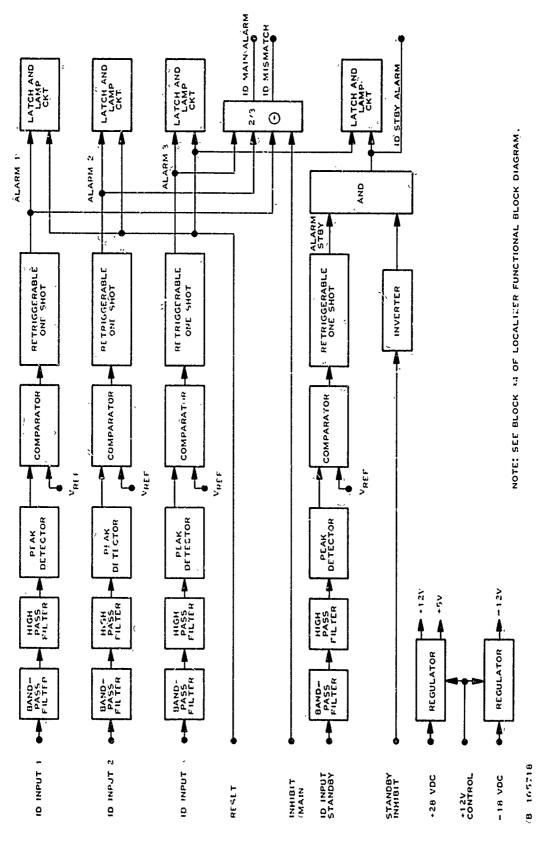


Figure A-14. Identification Monitor Channel

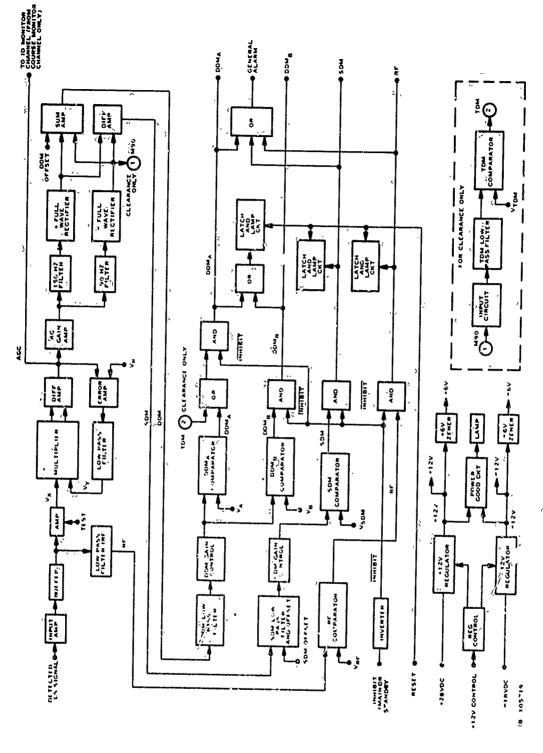
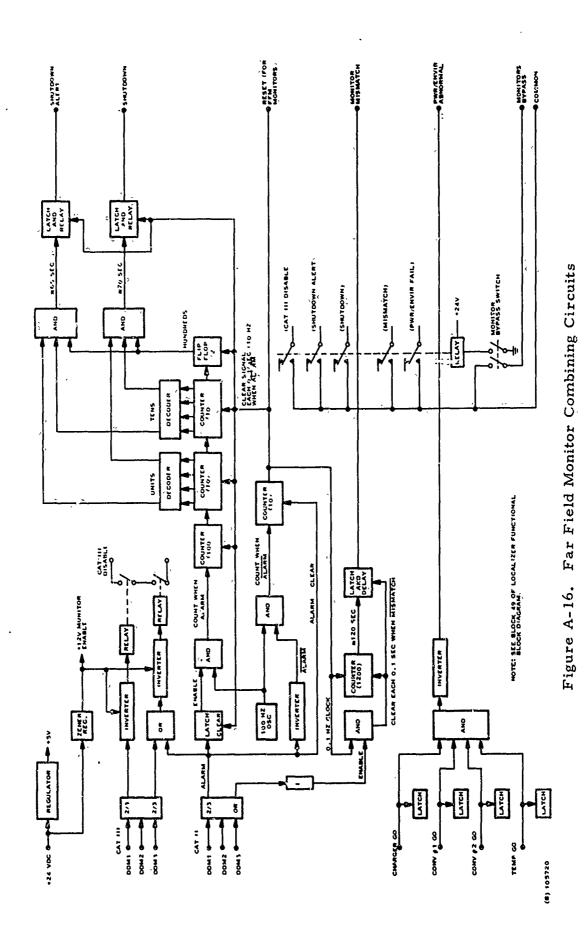


Figure A-15. Monitor Channel



A-27

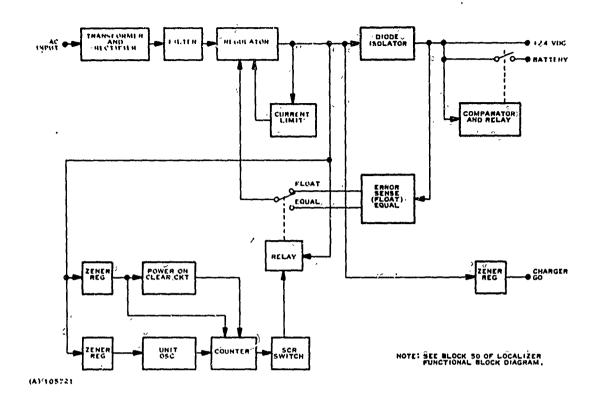


Figure A-17. Far Field Monitor Battery Charger

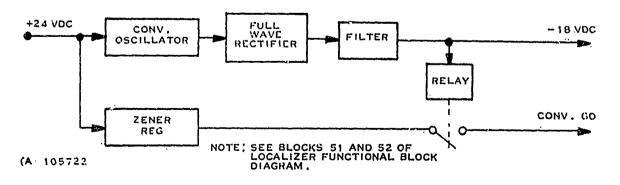


Figure A-18. Far Field Monitor Dc/Dc Converter

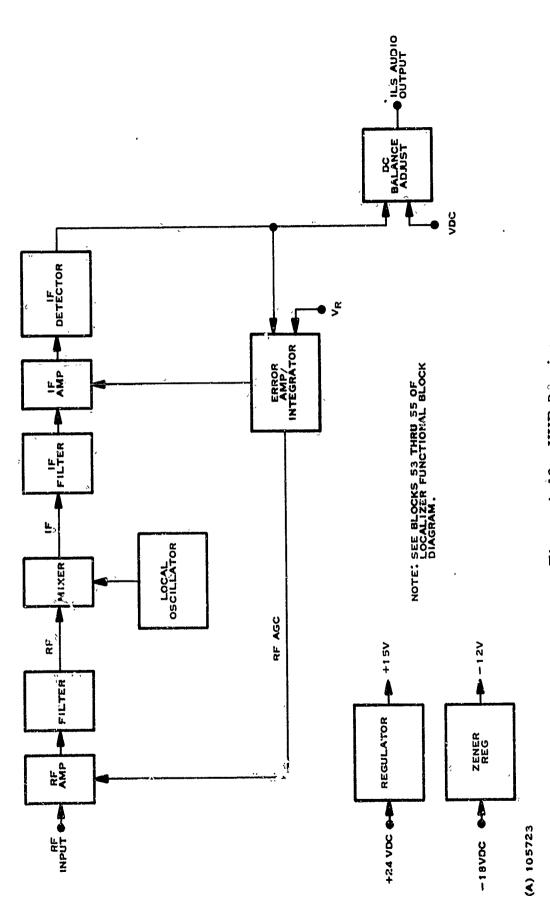


Figure A-19. VHF Rêceiver

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Appendix B
Glideslope Detailed Functional Block Diagrams

## Appendix B

## Glideslope Detailed Functional Block Diagrams

This appendix consists of detailed functional block diagrams for the glideslope. Figures B-3 through B-13 cover the numbered blocks for figure B-1. Figure B-2 and the accompanying table B-1 detail the glideslope control unit.

Table B-1. Definition of Signal Names (Glideslope Control Unit, Figure B-2)

Namė "	Definition
A <sub>BÂT</sub> :	Alarm due to a drop in the main battery voltage.
A <sub>CONV</sub> :	Alarm on one of the DC/DC converter voltages.
A <sub>MD</sub> :	Misalignment detector alarm with whibit.
A <sub>PE</sub> :	Power/environmental alarm sent to remote control.
A <sub>s</sub> :	Alarm due to standby monitors.
A <sub>S(D)</sub> ;	Alarm due to standby monitors, delayed.
A <sub>SM</sub> :	Alarm due to standby monitors, memorized.
AB:	Abnormal condition signal.
AB <sub>MON</sub> :	Abnormal condition signal due to monitor channel alarm.
AB <sub>MON<sub>RC</sub>:</sub>	Monitor ularm sent to remote control.
AC:	AC power alarm from one of the two battery chargers.
BC:	Battery charger alarm from one of the two chargers.
BLINK:	Blinker output signal, a square wave oscillator.
Ç:	Cycling command signal for transmitters.
C <sub>ANT</sub> :	Command to have transmitter no. 1 connected to the antenna.
C <sub>ANT</sub> :	Command to have transmitter no. 2 connected to the antenna.
·c <sub>1</sub> :	Command to turn on transmitter no. 1.
c <sub>2</sub> :	Command to turn on transmitter no. 2.
CAT II RC:	Signal to remote control used to determine Category II status.
CAT III <sub>RC</sub> :	Signal to remote control used to determine Category III status.

Table B-1. Definition of Signal Names (Glideslope Control Unit, Figure B-2) (Continued)

Name	Definition
CONTROL:	Cycle command (MAIN, STBY, or OFF).
CL <sub>11</sub> :	Category III DDM clearance alarm, monitor no. 1.
CL <sub>12</sub> :	Category III DDM clearance alarm, monitor no. 2.
CL <sub>13</sub> :	Category III DDM clearance alarm, monitor no. 3.
CL <sub>21</sub> :	Category III SDM clearance alarm, monitor no. 1.
CL <sub>22</sub> :	Category III SDM clearance alarm, monitor no. 2.
CL <sub>23</sub> :	Category III SDM clerrance alarm, monitor no. 3.
CL <sub>31</sub> :	Category III RF clearance alarm, monitor no. 1.
CL <sub>32</sub> :	Category III RF clearance alarm, monitor no. 2.
CL <sub>33</sub> :	Category III RF clearance alarm, monitor no. 3.
CSE <sub>11</sub> :	Category III DDM course alarm, monitor no. 1.
CSE <sub>12</sub> :	Category III DDM course alarm, monitor no. 2.
CSE <sub>13</sub> :	Category III DDM course alarm, monitor no. 3.
CSE <sub>2:1</sub> :	Category III SDM course alarm, monitor no. 1.
CSE <sub>22</sub> :	Category III SDM course alarm, monitor no. 2.
CSE <sub>23</sub> :	Category III SDM course alarm, monitor no. 3.
CSE <sub>31</sub> :	Category III RF course alarm, monitor no. 1.
CSE <sub>32</sub> :	Category III RF course alarm, monitor no. 2.
CSE <sub>33</sub> :	Category III RF course alarm, monitor no. 3.
CSE 111:	Category III DDM course alarm, monitor no. 1.
CSE 112:	Category III DDM course alarm, monitor no. 2.
CSE 113:	Category III DDM course alarm, monitor no. 3.

Table B-1. Definition of Signal Names (Glideslôpe Control Unit, Figure B-2) (Continued)

Name	Definition
I <sub>C</sub> :	Inhibit signal to inhibit transmitter cycling capability.
I <sub>MAIN</sub> :	Main inhibit to main monitor channels.
I'ON'	inhibit signal due to power turn-on.
$^{\mathrm{I}}\mathbf{T}^{:}$	Inhibit signal due to transfer con manual.
<sup>I</sup> s:	Inhibit signal due to shutdown commands, either auto or manual.
I <sub>STBY</sub> :	Standby inhibit to standby monitor channels.
L <sub>AB</sub> :	Abnormal status lamp signal.
L <sub>AC</sub> :	AC power alarm status lamp signal.
L <sub>BAT</sub> :	Battery alarm status lamp signal.
L <sub>BC</sub> :	Battery charger alarm status lamp signal.
$_{\mathrm{L}}^{\mathrm{c}}$ :	DC/DC converter alarm status lamp signal.
L <sub>MD A</sub> :	Misalignment detector alarm lamp.
L <sub>MD BY</sub> :	Misalignment detector bypass lanıp.
L <sub>MLB</sub> :	Misalignment detector bypass lamp.
$^{\mathrm{L}}_{\mathrm{MM}}$ :	Monitor mismatch status lamp signal.
L <sub>N</sub> :	Normal status lamp signal.
L <sub>S</sub> :	Shutdown status lamp signal.
L <sub>TEMP</sub> :	Temperature alarm status lamp signal.
L <sub>X1</sub> :	Transmitter no. I connected to antenna status lamp signal.
L <sub>X2</sub> :	Transmitter no. 2 connected to antenna status lamp signal.

Table B-1. Definition of Signal Names (Glideslope Control Unit, Figure B-2) (Continued)

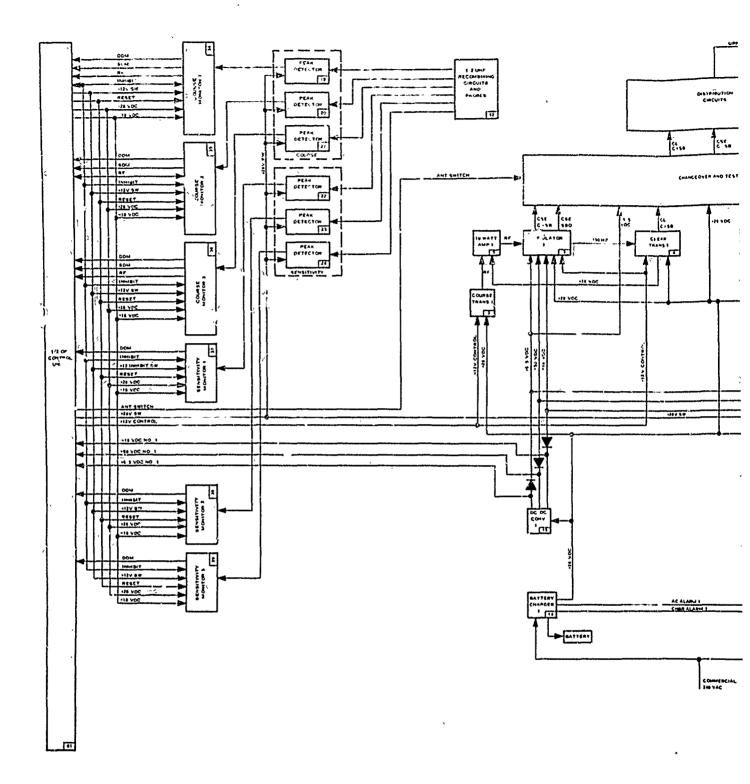
Name	Définition
LOC:	Local control of transmitting unit.
LT:	Transfer signal memorized.
MA <sub>CL</sub> :	Clearance monitor alarm.
MACSE 11	Course monitor alarm, Category II alarm limits.
MACSE :	Course monitor alarm, Category III alarm limits.
MA <sub>NF(D)</sub> :	Near field monitor alarm which is delayed.
MA <sub>s</sub> :	Shutdown command from moniter alarms.
MA <sub>SEN</sub> :	Sensitivity monitor alarm.
MA <sub>T</sub> :	Transfer command from monitor alarms.
MAIN:	Main transmitter "on" status signal.
MAIN <sub>RC</sub> :	Signal to remote control used to determine MAIN status.
MD <sub>A</sub> :	Misalignment detector alarm without inhibit.
MD <sub>BYL</sub> :	Misalignment detector bypassed locally.
'MLB:	Monitors ocally bypassed.
MM <sub>CL</sub> :	Clearance monitor mismatch.
MM <sub>CL/NF</sub> :	Clearance or near field monitor mismatch.
MM <sub>CSE<sub>111</sub>;</sub>	Course monitor mismatch, Category III alarm limits.
MM <sub>NF(D)</sub> :	Near field monitor mismatch which is delayed.
MM <sub>SEN</sub> :	Sensitivity monitor mismatch, Category III alaım limits.
NF 1:	Category III DDM near field alarm, monitor no. 1.
NF 2:	Category III DDM near field alarm, monitor no. 2.

Table B-1. Definition of Signal Names (Glideslope Control Unit, Figure B-2) (Continued)

Name	Definition
NF 3:	Category III DDM near field alarm, monitor no. 3.
OFF:	Both transmitters ''off'' status signal.
OFF <sub>RC</sub> :	Signal to remote control used to determine OFF status.
ON/OFF:	Front panel control unit power supply control.
REM:	Remote control of transmitting unit.
RESET:	Signal to reset alarm memory latches.
S <sub>CL</sub> :	Standby clearance monitor alarm - DDM, SDM, or RF with Category III limits.
S <sub>CSE</sub> :	Standby course monitor alarm - DDM, SDM, or RF with Category III limits.
s <sub>M</sub> :	Shutdown signal memorized.
s <sub>sen</sub> :	Standby sensitivity monitor alarm - DDM with Category III limits.
s <sub>0</sub> :	Both transmitter are selected to be off.
s <sub>1</sub> :	Transmitter no. I is selected as main.
s <sub>2</sub> :	Transmitter no. 2 is selected as main.
<u>s</u> <sub>12</sub> :	Selection of transmitter no. 1 memorized.
s <sub>12</sub> :	Selection of transmitter no. 2 memorized.
SEN <sub>11</sub> :	Category III DDM sensitivity alarm, monitor no. 1.
SEN <sub>12</sub> :	Category III DDM sensitivity alarm, monitor no. 2.
SEN <sub>13</sub> :	Category III DDM sensitivity alarm, monitor no. 3.
STBY:	Standby transmitter "on" status signal.
STBY <sub>RC</sub> :	Signal to remote control used to determine STAND-BY status.
TEMP:	Temperature alarm inside main cabinet.

Table B-1. Definition of Signal Names (Glideslope Control Unit, Figure B-2) (Continued)

Name	Definition
XF/Å:	Transfer command due to XFR1 or XFR2 (redundant for remote recognition).
XFR1:	Transfer command due to course and sensitivity (redundant).
XFR2:	Transfer command due to clearance and near field (redundant).
+12V CONTROL:	Control signal to turn on monitor channels.
-18V:	A common-18v from the two DC#DC converters.
-18 <sub>1</sub> :	-18 volts from converter no. 1.
-18 <sub>2</sub> :	-le volts from converter no. 2.
+28V BATT:	The voltage of the main batteries.
+51:	+5 volts from converter no. 1.
+52:	+5 volts from converted no. 2.
-50 <sub>1</sub> :	-50 volts from converter no. 1.
-50 <sub>/2</sub> :	-50 volts from converter no. 2.



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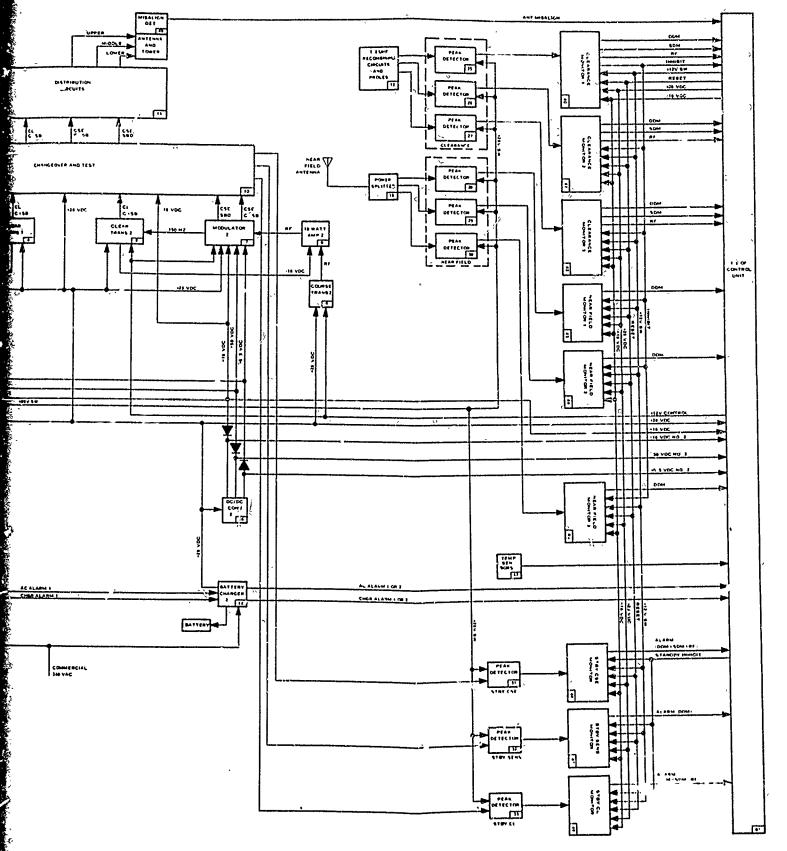
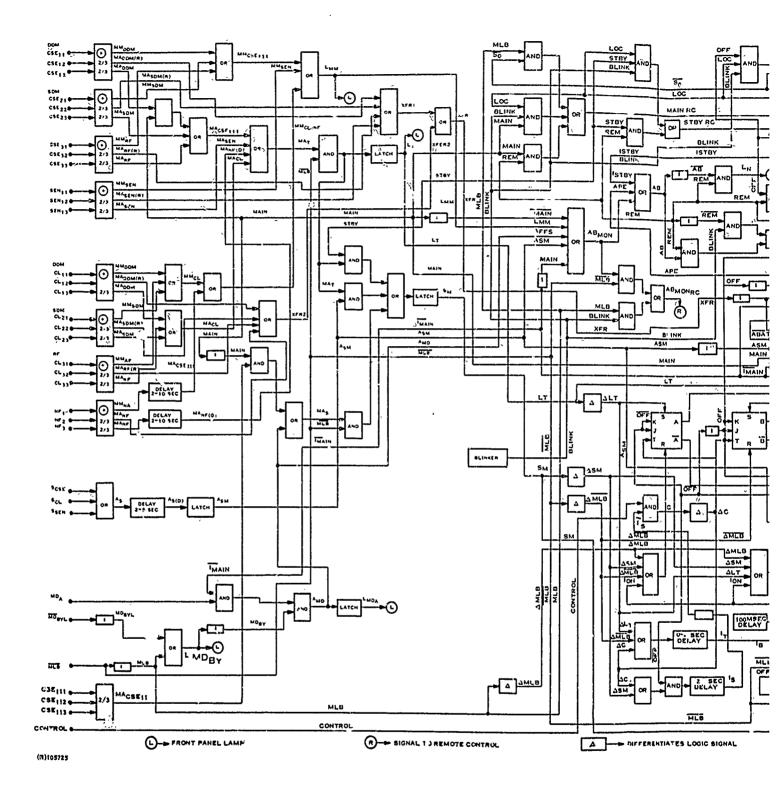


Figure B-1. Glideslope Station

B-9/B-10





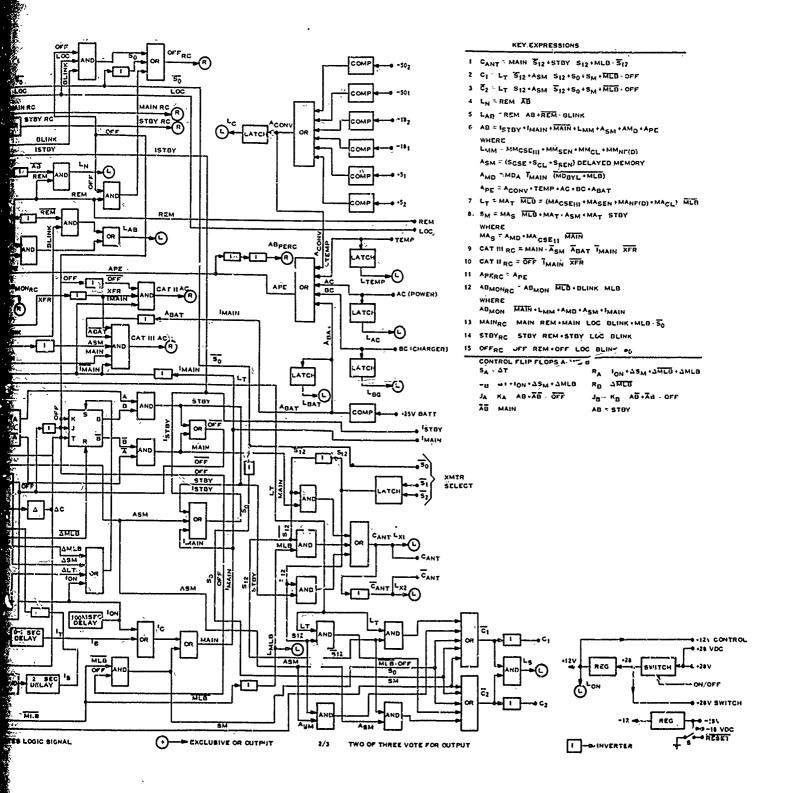
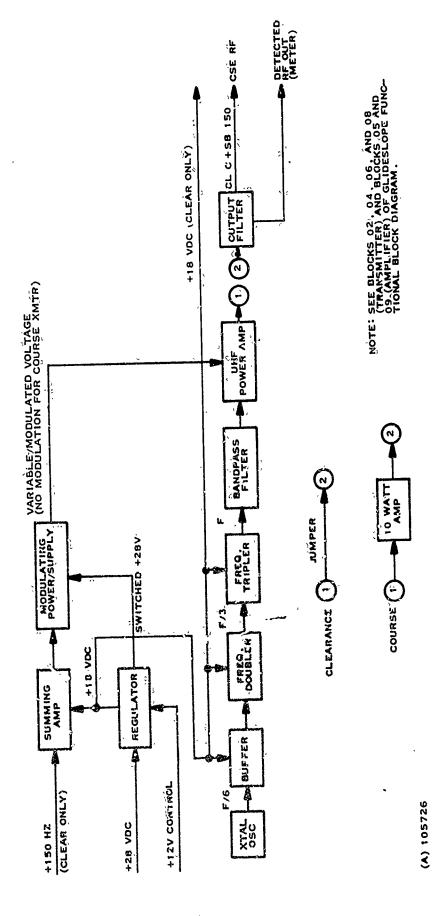
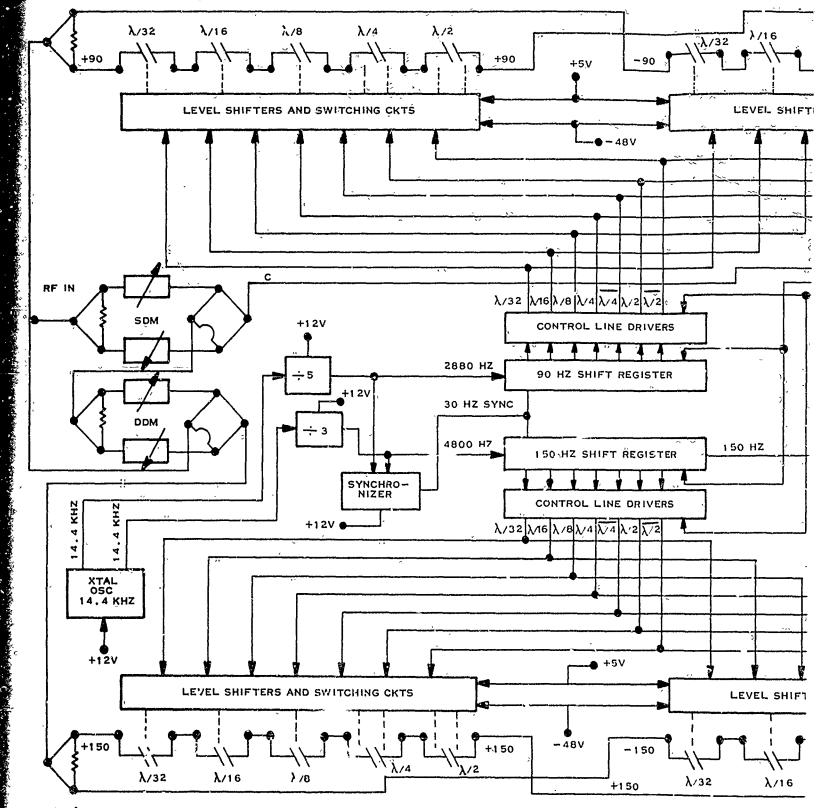


Figure B-2. Glideslope Control Unit



UHF Transmitter (Course and Clearance) and 10-Watt Amplifier Figure B-5.



NOTE: SEE BLOCKS 03 AND 07 OF GLIDESLOPE FUNCTIONAL BLOCK DIAGRAM.

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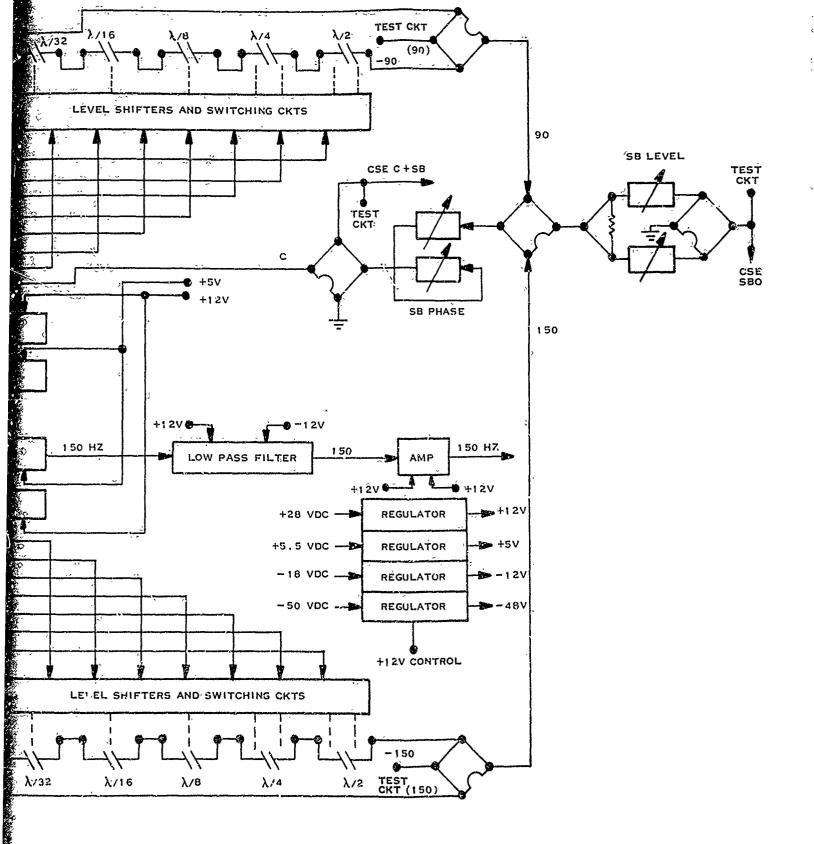
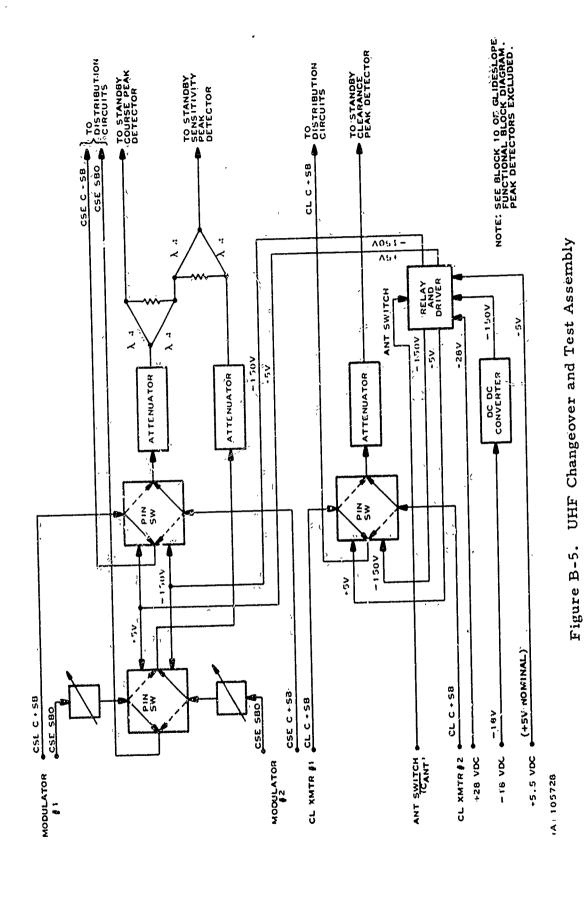
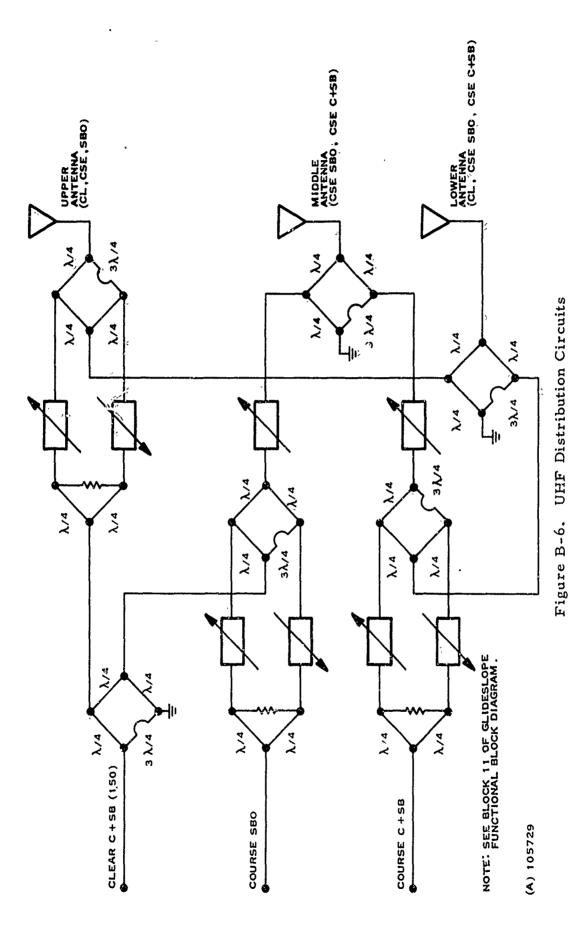


Figure B-4. UHF Modulator

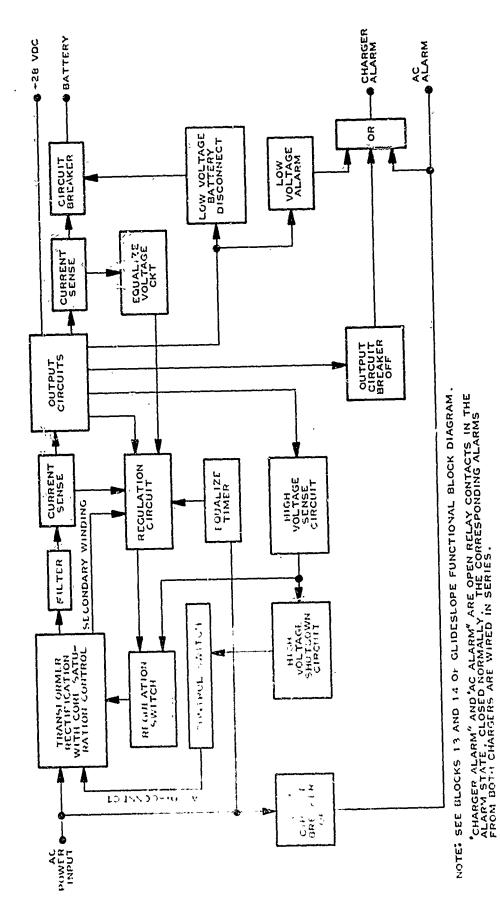
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B-17



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Figure B-9. Battery Charger

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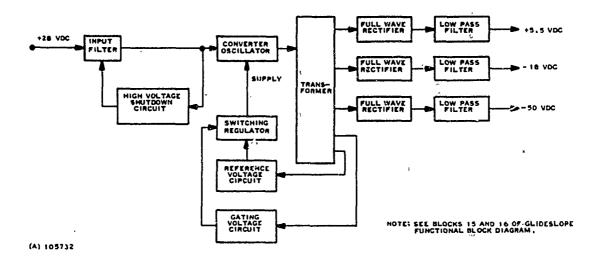


Figure B-10. Dc/Dc Converter

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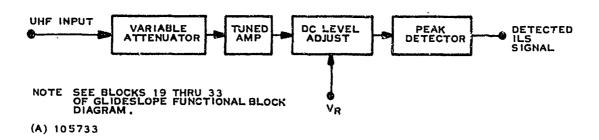


Figure B-11. UHF Peak Detectors

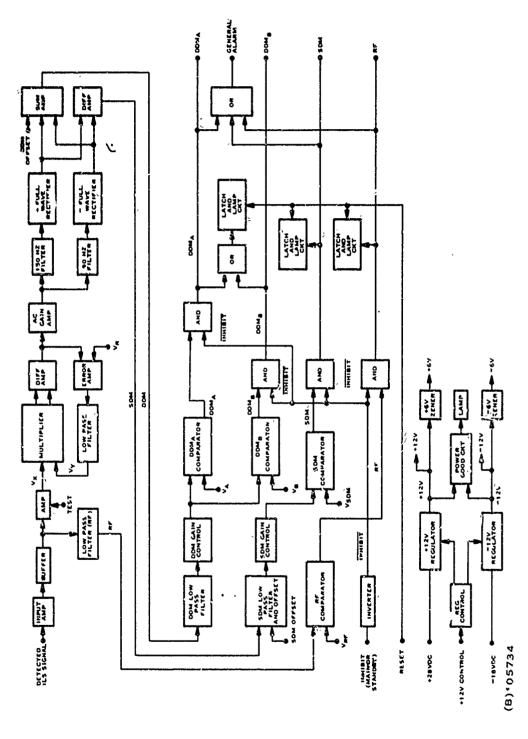
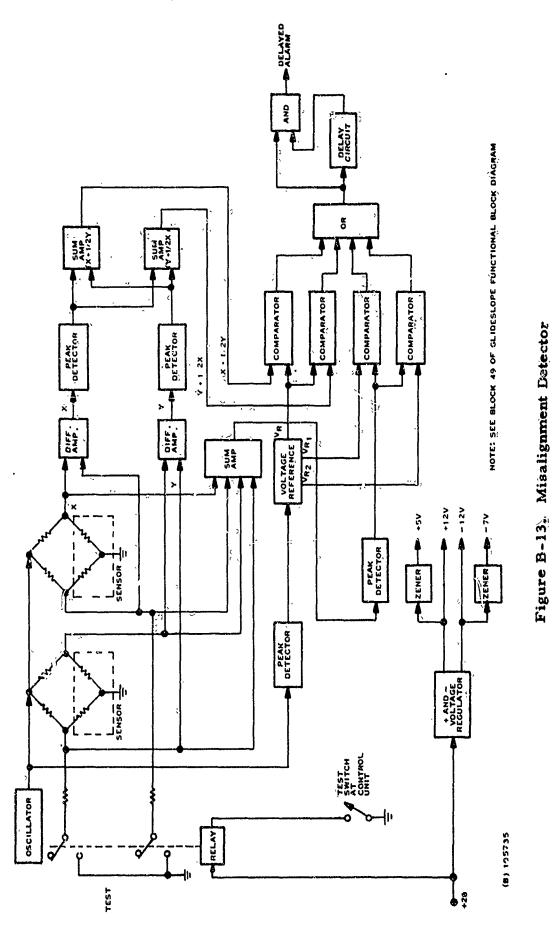


Figure B-12. Monitor Channel



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B-23/B-24

Appendix C

Localizer Failure Analysis

## Appendix C Localizer Failure Analysis

This appendix, referred to in section 7.0, consists to the failure analysis for the localizer, as shown in table C-1.

Table C-1. Localizer Failure Analysis

Administration of				Svetem	System Operation	-	Faile	Failure Indications				
				After	After Fallure	٠.				Failure	, , , , , , , , , , , , , , , , , , ,	
Name (%)	Function	Node	Falure Effect	Cát III	Car II	oir o	Control	Unit	Other	(4× 106)		
Course Trans   02 mitter MSN   or or STANI Bir   m7		Lois of all modulation.	Loss of ID radiation and warning signal capability.		×	< 25	VON ABN" and "STBY"	"ABN" and "TRANS-	I. D. mon. élarme	1.446 NNA 2 12A or 17A	'Transfer would not occur on failure of standby unit. Loss of Cat. IIi status would occur even though "main" is still,	
	the transmitter b, the 1020 Hz ID tone and also the low frequency warning laining when not essary?	Lose of RF	Loss of course C-SB and SBO signable.		. ×	1.441	"MON" ABN" and	"ABN" end "TRANS-	Course, senditivi- ty, and near field	7. :50 \NB	operational. NOTE Atthough pear field monitor lights are boil, their alarms.	
	Reproducêd from best available co	þy.		, ,	,	5			monitor. Llarms on; main cab; inet.		NOTE  Note the failure rate of each separate item, dentified in the L.D. No. column.	
Clearan e 3 Transmitter or MAN e (1)	The elegance transmit- ter delivers a elegrance to by to the anomae, is elegance distribution	Loss of all modulation.	Loss of sudebands on the C.SB-sig-		×	3 4 Jan	MON ABN" ABN" Yan	"ABN" and "TRANS-	Alarms on clearance monitors.	1.446 \\XA	'Transfer' would not occur on failure of standby unit.	l .
	rocts, in addition VIII arrested and the safe and senerated for the operation of clearance Nife safes.	lox of RF	ioss of clearance C-SB and SBO six-		×	स् र रा	"MON ABN" And "STBY"	"ABN" and "TRANS- FER!"	Alarms on clea-ance monitors.	7, 150 'NB		
Sidehand Curs of crant NV. or or NTANER (F)	Froudes clearance SBO signal to the distribution circuits.	Loss of output signal.	SEO signal.		×	: < 4:	"MON ABN" and "STBY"	"ABN" and "T) ANS-	Alarma on clearance monitors.	10. 250'' 'N	"Transfer would not occup on, failure of standby unit.	1 1
Viodulator of STANDBY (N	Provides course VIIF Later amplitude modu- lated by a 40 filt and 150 II sagnal, CSE G-SB II provides the course SBO signal, A LOW frequency 10-150 It sagnal, and which feeds the clearance transmitter, and a 30- transmitter, and a 30- sifo IIz signal feeding the sideband generator.	Loss of low of freq. oscil- lator 114. Kitz) result- ing in loss of all 90 Hz. and 190 Hz. and 190 Hz. modulation.	Loes, of the follow- my, yetem signals: 1. S. We. 15; C.SB n city-ance C.SB 3. LF 90.156 4. Clastance SBO 5. Course SBO 6. SB in course C.SB		×		Abn''' STBY	ABN" and. "TRANS- FER"	Alatins on all course, sensitivity, ty, near field, and clearance mains	2. 413 2.XA	"Tranifer" would not occur on fallure of standby unit. Losp of Cas. Ill status would occur even though "main" is still operational.	

Table C-1. Localizer Failure Analysis (Cont'd)

Page 2 of 27		Personal	£ -		Noc bazardosa – signal filli within Cet. Ill toldegance.	Not bazardous - signal still within Cet. Ill tolerance.	Ī
		Paters fax 10 h	0.413 'NB	1.453 ANC	2.426 NND NND	2.426. <sup>3</sup> NE	12. 832 ·
	, suc	Ósper	Alarms on all course, sonsitivity, and near field (monitors.	Alarma on all course. sengitivi- ty, near field and clearance momitors:	5	- ;	Alarms on all course. scasitivity, and near field monitors
"	Failure Indications	Control Poit	"ABN" and "TRANS- FER"	"ABN" and "TRANS. FER"	NONE	NONE	"ABN" and "TRANS- F. TS".
,	Fai	Pemáte Control	"MON ABN" and "STBY"	ABN" ABN" And "STBY"	NONE	NONE '	"STBY"
	System Operation	After Failure	×	× (		·	*
,	System	Carim		, , , ,	×	×	
		Fallure Effect	Loss of SB in course CSB Signal and course SBO signal.	Out of tolerance course and clearance C+SB and SBO signals.	Sight disfortion of the course C+SB and SBO signsle.	Distortion some- what more than 1/32 of the Ct. res CsS and SBO signsle.	Out of tolerance course C+5B and SSO signate.
		Fallure Mode	Losacot VelF carrier to liggital phas- ling chts to- sither or. both of the both of the phase shift- ers):	Loss of 90 or 150 di- videra, syn- chronisation effecultry or 90/159 Hz shift reg- istera.	Loss of N/32 driving oignature of cither the 90 Hz phase shift-er.	Loss of A/16 driving eig- mal to the delay lines (either the 90Hz or 150 Hz phase	Lose of A/8. A/4. X/4. A/2 or X/2 signal to the Jelsy line. (either the 90 Hs or 150 Zis phase
Subsystem LOCALIZER STATION		Function					
1.0CA11	itton	1. n. No.	8 8 8				
Subayatem	Identification	Rame	Modulator (Continued)			·	

Table C-1. Localizer Failure Analysis (Cont'd)

		Semarks			•		If enother cerresponding mon- tive alarm failure occurred in me of the remaining two mon- tives, immediate localiner absideers will result.	·
ابران	Failure	Rate ()	1.302 <sup>3</sup> NG	1.552 ANH ANH	0.388 And	0.756 ANJ	13.310 74.6	3.390
ons.		Other	Alarms on all course, se, jilivi-tr, and seer field monitors.	# 0 1	Clarms on all clear- ance mon- itore.	Alarms on all clear- ance mon- itors.	Alarm Highers ca defective mession classed.	
Failure Indications		Control	"ABN" and "TRANS. F.ER"	"ABN" and "TRANS-	"ABN" and "TRANS- FER"	"ABN" and 'TRANS- FER"	"MONI- TOR MIS- MATCH" "ABH"	NONE
Fai		Remote	"MON ABN" and "SIBY".	ABN" and "STBY"	"MON "ABN"	ABN" ABN" SYBY"	ABN" and "MAIN"	NONE
ation	٠.	٥		/			·	
System Operation	After Failure	Cat II	×	×	×	×		
Syste	7	Cat III		•			×	×
		Fallure Effect	Out of tolerance course C+SB and SBO signals.	Out of toleyance crisarance C.SB and SBQ signals.	Lose of modulation for clearance trans- mitter resulting in SB loss of clearance C+SB.	Loss of clearance SBO eigns).	Loss of 2 of 3 mon- lior voting capabil- ity. Now dependent on 1 of 2 remaining monitorie for system control (transmitter transfer częwility).	Loss of 2 of 3 mon- tor voting caisa- bility. Now de- pendent upon 2 of 2 remaining moni- tors for system con- trol.
	;	Mode	Loss of +90, -90, +150, or -150 Hz phase shift- er RF sig- nel.	Loss of either the 90 Hz or 150 Hz sinusoi- dal signal dor clear- ance trans- russion.	Loss of 904 150 Hz sig- nal.	Loss of 90- 150 Hz sig- nal.	Loss of menitoring ability, producing alarms.	Loss of monitoring ability, producing no alarms.
		Function					Provide monitoring of the course position (DDM), the % modulation (SDM), and the course RF power level.	·
tion		ç. Ç	03 08				35.	
Identification	-	Kan Trans	Kodulator (Continued)				Course Mon- itor CHAN- NELS (1, 2, or 3) (MAIN)	

Table C-1. Localizer Failure Analysis (Cont'd)

Pare 4 of 27		Remarks			if another corresponding mon- itor DDM failure occurred in one of the remaining two mon- itors, immediate localizer shutdgen will result.	Only DDM monitoring circuitry is critical,	Only DDM monitoring circuitry		SDM and DDM are strapped to provide one general alarm output.
,		Rate Ox 1061	13.310 <sup>1</sup> 46A	લે9₹ <sub>\</sub> 06€'5	9.367 <sup>A</sup> NA	2 892 <sup>A</sup> NB	725°6	2,892 ,47B	31. 099 51. 51. 099
	\$uc	Other	Alarm light(s) on standby course monitor.	,	Alarm lightts) on defective monitor channel.		Alarm light(s) on standby sensitivity monitor.	,	Alarm light(s) on defective near ffeld monitor.
	Failure Indications	Control Unit	"ABN"	NONE	"MONI- TOR MIS- MATCH" and	NONE	·`ABN"	NONE	"XCN": TCEOTIS. NATCH: and "ABN":
	Fall	Remote Control	"MON ABN" and "MAIN"	NONE	"MÓÑ ABN" and "MAIN"	NONE	"MON" ABN" and "MAIN"	NONE	"MAIN"
; ;	tion	5	5					<del></del>	
	o O	t III Cat II	×				×	,	
	System Operation	Cat III		`````````````````````````````	×	×		×	×
	,	Fallure, Effect	Shutdown of standby transmitter	Loss of standby course monitoring.	Loss of 2 of 3 mon- itor voting capabil- ity. Now dependent upon 1 of 2 remain- ing monitors for system control.	Loss of 2 of 3 mon- ner voting capabil- nry. Now dependen upon 2 of 2 remain- nr monicas for system control.	Shutdown of the standby transmitter.	Loss of standby course monitoring.	Loss of 2 of 2 mon- itor capability. Now dependent upon re- myning monitor for system control.
		Fallure Mode	Loss of monit ving ability, producing	Loss of monitoring ability, producing no alarms.	Loss of monitoring ability producing alarms.	Loss of monitoring ability producing no alarma.	Loss of mon'toring ability producing alarms.	Loss of monitoring ability producing no alarms	Loss of monitoring ability producing alarms.
Subsystem LOCALIZER STATION		Function	Same as main course monitor channels except monitors vourse pars-meters of standby unit.		Provide mont fing of the course width (DDM).		Provide monitoring of the standby course width (DDM).		Provide monitoring of the near field course position (DDM).
OCA:	lon	No.	95		38. 39. 40		<b>+</b>		7 5 7
Subsystem	Identification	Ite'm Name	Course Moni- tor Channel (STANDBY)		Sensitivity Monitor CHANNELS 1. 2 or 3 IMAIN		Standby Sen- sitivity Mon- stor Chanzel		Near Field Monitor CHANNELS i or 2

Table C-1. Localizer Failure Analysis (Cont'd)

Page 5 of 27		Remarks	Non-hazardous - near fleid monitoring considered not essential for Cat III operation.	If another corresponding moni- tor alarm failure occurred in one of the remaining two moni- tors, immediate localizer abut- downwill result.			,	"Transfer" would not occur, ou failure of standby unit: Loss' of Cat. III status would occur even though "MAIN" is still operation-	<b>:</b>
	Failure	Rate (A.v. 10 <sup>6</sup> )	3.822 <sup>1</sup> NB	14.280 <sup>k</sup> NA	5, 551 <sup>1</sup> , vB	14. 280 <sup>λ</sup> 48 <b>A</b>	5,551 λ <sub>4</sub> Γβ.	3.949. <sup>A</sup> NA	13, 134 <sup>A</sup> NB
ĺ	one	Other	, , , , , , , , , , , , , , , , , , ,	Alarm lightfal on defective clearance monitor.		Alarm (light(s) on standby clearance monitor.	ĺ	Alarms on ID moni- tors.	Alarms on 13. 1 I. D. mon., ANB itors.
	Failure Indications	Control Unit	NONE	"WON!- TOR MIS- WATCH" and "ABN"	NONE	"ABN"	NONE	"ABN" and "TRANS-	"TRANS- FER"
	Fa.	Off Control:	NC. E	"MON ABN" and "MAIN"	NONE	WVI Puc 	NONE	"MON ABN" and "STBY"	ARN'' And "STBY"
	Ition	oic					.,		
	O	III Cat II		<u>,, 1</u>		×	٨	×	×
	System Operation	Cat III	×	×	×	,	×		
		Failure Fifect	pas of near field	Loss of 2 of 3 mon- itor voting capabil- ity. Now dependent upon 1 of 2 remain- ing monitors for system control.	Loss of 2 of 3 mon- itor voting capabil- ity. Now dependent upon 2 of 2 remain- ing monitors for system, control.	Shutdown of stand- by transmitter.	Loss of standby clearance monitor-	Transfer 'grand- by unit.	Transfer to stand- by unit.
		Failure Mode	Loss of monitoring ability producing no alarms.	Loss of monitoring ability producing alarm.	Loss of monitoring ability producing no alarm.	Luss of rountoring ability producing slarm.	Loss of monitoring ability producing no alarm.	Loss of ID signal taudio).	Loss of code or keying.
Subsystem LOCALIZER STATION		Function		Provide monitoring of the clearance DDM, " modulation and clear- ance RF power level		Same as main clearance monitor changes except in interes clearance pas- rameters of standing	,	Provides a beyed 1920 the audio signal (ID) TONE) to aircraft for TONE) to aircraft for	identification.
OCAL	140.0	î. p.	41 52	£ 7 5 4		‡		, F.	
Suhayaterr 1	Identification	lten Name	Near Freid Monitor CHANNELS	Tearance Wester CHANNELS No. 1, 2 or 3 MAVN		Clearante Monitor Channel (STANDBY)		I D Unit	
		7	Reproduci besi avai	lable copy.	C-	6			

Table C-1. Localizer Failure Analysis (Cont'd)

	Kernarba	After a nominal 70 second delay, the "Far Field GO" light will go "off" and the "FF SHUTDOWN" light, will come "on" at the control unit.		Only input gating circuitry may be basardous. (Effects monitoring circuitry).	Redusdancy has been incorpu- crated so that performance downgrade is achieved in the event of a "True Cat III Alarm condition." NOTE Lose of I.D. monitoring is not basardous.	Not basardous - Cat III integral and far field monitoring still effective.
	AX 110	1. 827 <sup>1</sup> 1A	3, 507 1, 18	2 12 13 13 13 13 13 13 13 13 13 13 13 13 13	3,470 1,269 1,229 (redund) NIDI = 0,140 (gate) NIDE = 0,700 (logic)	2. 256 1E
ons	Other	The FFM processes the 'no signal" condition.	The FFM processes the 'no signal" condition,	No mis- match on monitor channels.		
Failure Indications	Contrôl	'TRANS- FER." "SHLT- DOWN" and "ABNOR-	"SHUT - DOWN" and "ABNOR- MAL"	"MATCH" and "ABNOR- MAL"	(NONE)	(NONE)
12	Rémote Control	MON ABN" and "OFF"	"MON ABN" and "OFF"	ABN" ABN" abd "MAIN"	(NONE)	(NONE)
irin	ğ	×	×	1,42		/
System Operation	After Fallure		•	,		
System	Cat III		41.0	×	×	×
	Fallure Ellers	Gusse both the main and the stand-by transmitter to by transmitter to thutdown immediately after the transfer.	Causes both the main and the stand-by transmitter to by transmitter to abutdown immediately.	Mismatch conditions do not effect cate- gry parformance: however-failure of input gates may be hazardous.	Cat III parameter impositoring of the integral course, sensitivity, I. D., and/or clearance is wittenily gradered useless.	Results in \$1000 of near field and/or far field Cat II monitoring capabil- ity.
	Failure	Gentration of an erro- neous trans- fet tignal. due'n alaxm processing circuitry.	Ceneration of an error neous shut- down signal due to alarm processing circutty.	Generation of an erro- neous mis- match sig- nal,	Inability to process a retailer aignal from the integral course sence the fitting.  I. D. and or clearance monitore.	Inability to process a shutdown signal, in- ilisted by the NF. FF. d/or Cat
,	Finction	The control unit process.  as alarms received from the ronaltor channels.  frow the standy is and mitter, to transfer main to standy, to shudown both	dirate a monitor mis- march, in addition, the control unit generates in- hibit signals, displays both locally and remotely transmitter and category transmitter and category	tous power/temperature alarm conditions for both the main shelter and far- field monitor operational features, such as bypass of monitors, main unit select, memoritation of sharm; are also associ- sted with the promite unit.		
100	r. 5.	<b>.</b>				
Identification	liem Name	Control Unit				

Table C-1. Localizer Failure Analysis (Cont'd)

Page 2 of 27		Remarks	Not beardous - Cat III per- formance and monitoring is useffected.	'Not bazardous - mismatch conditions do not effect Cat 111 performance.	If a standby transmitter fall- ure also occurs, immediate shutdown upon transfer will result.		Not bagardous - power/en- virouscount alarme merchy devergrade performace alba- der time dolay yet folk trans- nofttore are sti available.
	Pallure	Hale Charlos	0,560 AIF	3,746 <sup>N</sup> iG	986.11 986.11	<b>3</b> 17.	2.567 313
, , , ,	one	Oher		()		No alarme on styr monitorii.	
	Fellure andications	Control.	INONE	(NONE)	(NONE)	"ABNOR-	(MONE)
ĭ	Fel	Rémole	(NOWE)	(ΚΌΝΕ)	(NONE)	PAON ABN" ASA "PANIN"	(NONE)
	tión	ě		^	```	ļ	
	Opera	After Fallure				×	,,
	System Operation	Cat III	×	×	× ′		×
		Failure Fifeer	System wi to radiate lipossibly during a s draus-onl performer ed.	No serious exects on system opera- tion. Monitor mis- matches may not be recognized but: parameter "out of tolerance" condi- tions are still pro- cessed normally.	Ctandby unit mon- itoring is rendered	Causes the standby transmitter to shutdown. Main continues to operate in Cat II status.	Loss of romote secognition of respective alarm conditions; loss of downgrade rapabil-ity due to power/environmental sharms.
	,	Fallure Mode	inability to process a process a phytown signal, in- itiated, by either a double transfer or the NF. FF. to cor fee Re- eral alarm.	Inability to process a mismatch condition of any or all monitor sets.	Inablis v to process a standby atarm.	Generation of an erro-, neous stand- by slarm.	Inability to process any or all power/er vironmental alarms.
ER STATION		Function		*			
X ALLY	È	ر روز نور	3	· · · · · · · · · · · · · · · · · · ·			
Subsysten, LO ALIZER STATION	[des]tt.estun	llen. Vame	Minister Can	441			-

Table C-1. Localizer Failure Analysis (Contid)

					1	,						Page 8 of 27
fdentification	u.				Syayen	System Se ration	, uci	Fail	Failure Indications	one		
	r.p.	Function	Fallure	Fallure Fillers	Afte	After Fr bire	٠,	Remote	Control		Falure: Rate	in a contract of the contract
十	<u>.</u>		Mode		Out III	3, 30	3	Control	Unit	Gaer	14× 1061	
Continued)	5		Generation of an erro- neous bat- tery alarm.	No effect other than erroneoualy down- grading the system to Cat II atatus.	ì	*	± 44 €.41	ENVIR ABN" and "MAIN"	"ABNOR- MAL" and "EATT FAIL"		0.415 ÅK	Ne hazardousvatem still has the ability to operate on both transmitting units.
			Generation of any erro- neous power/en- vironmental alarm ex- cept a bat- tery alarm.	No effect other than an erroneous abnor- mal indication.	×	Down- grade to Cat II af- ter time delay.	C H <   # 2	POW ( ZNV)X ABW". ABW". MAIN"	MAL. MAL.  add  pcssibly thire  poyer or  terr pera-  ture alatim (ight,	.,	3.029 114	Not hazardous
			Generation of an erro- neous con- trol signal that shuts down the main trans-	After the main transmitter shuts down, the loss of radiation is detect- ed by the monitor chamels and trans- fer is initiated to the standby unit.	,	×	: <b>≤</b> 4 ± ′	Abn" and "STBY"	PEN." FEN." *ABN'	Alarms on some mon- tor, chan- nels.	0.420, 1M	Monitor channel alarm lights are unpredictable due to a race condition between the generated inhibit signal and the "bo signal" input alarm processing.
		<u>.</u>	Generation of an erro- news con- troi wignal that/hut doyn the stindby transmitting unit.	After the standby transmitter shute down, the loss of input signals to the standby monitor channels createn standby alarm conditions which are processed normally in the control unit.	·	×	: < a &	ABN" ABN" ABN" ABN" AAIN"	. Abn.	Alarms on some standby monitor channels.	0. 280 11 N,	This failure mode is not generated by monitoring circuitry; )honce, it may occur after a transfer to standby has occurred.
			Generation of an erro- neous con- trol signs! that shirs! down both transmitting units.	After a total shut: down is initiated, the loss of input signals to all mon- itor channels re- sidts in both a si- multaneous process- ing of a transfer and shutdown condition in the control unit.		<i>y</i> .	<u> </u>	MON ABN" 1	"TRANK". FER". "SHUT. and "ABN"	some mon- itor chan- nels.	0, 140 VIO	

Table C-1. Localizer Failure Analysis (Cont'd)

System Operation Fallure Indications Failure	Fallure Elfect Cat III Cat II Off Control Unit	to No failure effect or X (NONE) (NONE) 1.782 indication until an- outer failure oc- ine curred in the main or standby unit. At ing that time all control except the respective teasemitting unit value of case transmission.	<del> </del>	Ter of in MAIN, a trans. X "MON "TRANS. Alarme on 0.960 (as- Abn" FER" some "ig monitor in no line in the no. 5TANDBY a trans. In the no fer to OFF will oc- transfer MAIN sum. STBY" "ABN" channels. And monitor it is a momentary loss status)	The respective main  ABN" MAL"  ABN"  ABN" MAL"  ABN"  ABN  ABN
ration	Tě	, , , , , , , , , , , , , , , , , , ,	(NO)		<del> </del>
System Ope	Cat III Cat				
_	Fallure Effect	No failure effect or indication until another failure oc- curred in the main or standby ur.f. At that time all control signals would be processed onormally, except the respective transmitting until would not cesse transmission.	No failure effect or indication until a transfer command is received (due to some other failure). At that time all radiation will cease.	ff in MAIN. a trans- fer to STANIBY will occur, if in STANIBY, a trans- fer to OFF will oc- cur. This is due to a momentary loss of signal.	The respective main and/or standby mon- toor channels are inhibited and, here, rendered totally uselvse. Although the inhibit does not effect the far lield monior channels from alarmnns, the
	Failure Mode	inability to shutdown shutdown main or the standby fransmitting int.	Inability to gifect a change of units feed- ing the an-	Pre-mature change of units feed- ink the antennas.	Seneration of a con- tinuous main andfor retandby in- hibit to the monitor thannels.
	Function				
II.in	g è	ā			
Identification	Item Name	Continued!			

Table C-1. Localizer Failuré Analysis (Cont'd)

	ľ			`	1		-					
Identification	Efri				Syxten	System Operation	니 [	Ĩ.	l'allure Indications,	108.	I Astron	
ltern Name	<u>.</u> ;;	Finetion	Failure Môde	Faibure Fifteer	111 10	111 (29/11)	TE	Peninte	Control	Other	Rate 10%	Renarba
Continued)	6		inability to process a ruain inhibit to the ruon- itor chan- nele.	! 	×			(NONE)	NONE	,	2.658 11T	Failure mode virtually renders the standby, transmitter useliess.
			Inability to process a standby in- hibit to the standby monitor channels.	No effect on system operation - merely produce, slarms on all standby monitor channels after a transfer has already occurred due to another failure.	×			INONE	(NONE)		AIC	Not hazardous - atanúby mon- noring is meaningless efter a transfer.
			Generation of an erro- neous mon- itors locally hypassed signal:	fer s			×	"ABNOR-" MAL" (Ilashing: and "MAIN"	"MON LOC BYPASS" and "NOR-	·	A1W	Cat III and Cat II status taken away atthough both transmitters are still operational.
			Generation of an erro- neous shut- down alert signät.	No effect on system operation - only causes the transmission of a false shutdown warning signs!	×	•	<u> </u>	(NONE)	(NONE)		2. 252 <sup>3</sup> 1X	Not bakardous - only psychological implications.
			Inchility to generate a correct correct correct ciert signal.	System may shulddown instantaneously withou any warning to pilot.	×			(NONE)	(NONE)		7.693 71 Y	Not hazardous – abutdown warning not vital to syster; operation.

Table C-1. Localizer Failure Analysis (Cont'd)

The second secon

Paie 11 of 27	4.2	K. raths			"TRANSFER" would not occur on failure for standy unit. Loss of Car III attus would occur even though "main" is still operational.	Near field monitoring only monitors Cat II course limits. The strap option for SDM alarms will be employed to detect "NO SIGNAL" input conditions.
ě		Rate Ax 105)	0 339 12	1,506 1AA	0.675 \188 \188 \188 \188 \188 \1882 \0.338 \	0.789
		نيون نيون	No starms present on minn cab- yet due to mhibit.	FFM pro ceases the 'no signal' condition,	Alarma on I. D. mon- itor,	RF and SDM lights voil on the corresponding meat field monitor channel.
ŝ	Failure Indications	Control	"ABN" and "SHUT. DOWN"	All from panel lights off.	ABN And TRANS.	ABN'' ANG- WATCH'
i.	Fai	Remote Control	"MON ABN" and "OFF"	POW/ ENVIR ABN' and "OFF"	MON ABN" End 'STBY"	"MAN" and "MAIN"
,	t ton	وَّ	×	×		
	Oprir	1 2 2			×	
	Systen: Orgration	Cat III Cat II				×
		Failure Effect	All delay circuits produce an alarm output both a continuous main and alandb, mibit are genericed. An immediate shudown will result due to the cuts.	Air control logis, is rendered useless. Both transmitters shutdown monitors channels, however, are inhibited and, hence, do not alarm.	Transfer to stand- by unit.	Loss of the input signal to the corresponding near field monitor channel, causing a mon-itor instruction pendere upon remaining peak detector monitor for near iteld monitor. Now dependent upon 1 of 1 near field parameter monitor for system control. Shutdown
		Failure	Loss of -12 volts in con- trol uni power sup- gly	Loss of 12 softs in control and power sup- In Softs loss of switched 24v serata- neluded:	Loss of 1) signal 11º20 Hr. for ei- ther the main or standby unit.	Total loss of output rights to both AC and
SOLATIZER STATION		i inction				Each of the near field peak detectors receives its uppl signal from a near field antenna. The received RF signal is respirated RF signal is respirated RF signal into a low frequency signal into a low frequency signal into a low frequency signal. Dath of the presentative of the ourse presentative of the ourse RF power the Act is the demodalisted 40,110 fr.
SII.S OCALI		÷.	ē			i b n
System Subaystem IL	(dentity, attur	Ser.	Continced		1	Near Field Feak Driver

Table C-1, Localizer Failure Analysis (Cont'd)

**************************************			,	Sussen	Sustain One satisfy		Pailure Indications			
5		Failura	;	After	After Failure	٤	Control		Rate	\$ A B B B B B B B B B B B B B B B B B B
, o	Function	Mode	railure Fifere	Cat III	Cat 11 C	Off Control		Caber	(gul.xx)	
			will result if re- maining peak detect- or/monitor also				—; <u>;</u>			,
		incorrect (low) DC output sig- nal.	The zorresponding monitor channel processes the failure as being a drop in course RF power and an incresse in modulation percentage. Now despendent upon 1 of 1 for near field monitorial property of the processes in the failure of t	×		ABN" ABN" And "MAIN"	"ABN" and "MIS- MATCH"	RF and 0.38 SDM lights NoB on' on he cor- responding near field monitor charnel.	0.386 <sup>1</sup> NB	
នុក ខុឌ	Gack of the course peak detectors receives a sumulated course position unput signal. This input signal is obtained by a combination of signals obtained by prostinuty probes at the radiating antennes. Each peak defector then converts the RF signal into a four frequency signal, both DC and AGC. The DG is reparated by the RF resembles of the RF	Total loss of output signal (both AC and DC).	Loss of trpat sig- nal to correspond- ing a monitor, caus- ing a monitor mis- match. Dependence upon remaining two peak detectors/mon- tiors for integral course position and i. D. monitoring. Now dependent upon I of 2 course param- eter monitors for system control.	×	,	NOW. SMAIN. TMAIN.	ABN" and "MATCH"	RE and 0.78 SDM lights \NA SDM lights \NA corre- eponding monitor chainel and an alarm on corre- alarm on corre- light \na lig	0.789	Note that although both the re- maining two peak detectors/ 
	power: the AC is the demodulated 90/150/1020 Ms eignal.	Incorrect (low) DC output sig- nal.	The corresponding monitor claume! processes the failure as being a drop in course RF power and an increase in modulation percentage. Now despeadent upon 1 of 2 for integral course position monitoring.	×	·	NOT	"ABN" and " "YAIS-	OF and SDM lights SDM lights Corresponding course monitor channel.	0.386 2.8.5 3.8.5 3.8.5 3.8.5 3.8.6	

Table C-1. Localizer Failure Analysis (Cont'd)

					1
		Remarks	Although the remaining two pand distorters /monitors monitors monitors monitors monitors monitors monitors monitors with parameter, only an alarm one of them is required to initiate a transfer.		Atthough there will also be a loss of signal to the standby i. D. monutor, the standby inhibit signal will prevent the alarm from being processed.
À	Fallure	Rate 6, 13x 10 <sup>6</sup> )	0.789	).NB	0, 789 31.A
,	ions	Other	RF, SÚM, and DDM lights corre- iponding seneitivity monitor channel.	RF. SDM. and DDM lights corre- sponding sensitivity monitor chamel.	RF and SDM lights SDM lights corresponding standy course modification course channel.
.,	Failure Indications	Control C	"ABN" and "MATCH"	"ABN" "MIS- MATCH"	'ABN''
	<u>ē</u>	Remote	NOW	ABN" and "MAIN"	ABN" ABN" ABA
	tion?	orr			
	retem Operati	Cat II			×
	System Operation	Cat III	×	×	
		Failure Fifect	Loss of input signal to corresponding sensitivity monitor channel, causing a mionitor mismatch. Dipendene upon re- maining two peab diectors/monitors for integral course width monitoring. Now dependent upon for system control	The corresponding monitor channel processes the signal as being a drop in course RF power, an increase in modulation percentage, and a decrease in DDM. Now dependent upon 1 of 2 for course width monitoring, (Note that DDM is processed in the corresponding monitor channel).	Loss of input signal to the standby course monitor.  This, in turn, is processed as a failure in the standby transmitting unit, causing the standby unit to be shut dor a.
,		Failure Mode	Total loss of output signal (both AC and IX.).	integrett kow DC Gestput suc-	Total loss of output signal thoth AC and IDC).
		lunction	Each of the sensitivity peak dete, for a receives a simulated input signal, representative of the corrae width rdisplassement sensitivity? The imput signal is obtained by a combination of signals obtained by probes, at the redisting amenias. Each peak detering one one with the 18 stants and 18 s	quence, estant both DK read AC. The DC is rep- recentaints of the RB power the AC is the de- modulated '00, 150 Hz six- nat.  Reproduced from best available copy.	This peak detector re- ceves its input signal directly from the standby transmitting unit after proper attenuation. It essentially converts the standby G-SB signal into a low frequency signal. both AC and DC. The DC component represents the standby RF power level: the AC component is the demodulated 90;150/1020 Hz signals.
$\  \ $	Iton	ŝ,	23.		1.
	Identification	Yame	Sensuivity Peak Defer. Peak Defer. No. 2. or No. 1 (MAIN)		Standby Course Peak Detactor

Table C-1. Localizer Failure Analysis (Cont'd)

ا:		,	<b>k</b>	1		 
Page 14 of: 27		Renarks				Although the renaining two pask detector/monitors momitor that the clearance signal parameters, only an alarm on one of them is required to initiate a transfer.
	1 3 1 1 1	Rate (4, 10°)	0,386 \31B	0.789 <sup>3</sup> 32A	0.386 332B 	0,789 <sup>X</sup> NA
	1985	Other	RF and SDM lights "ON" on the cor- responding standby course monitor channels.	RF, SDM, and DDM lights OP!" on the corresponding standby sensitivity monitor;	RF, SDM, sard DDM lights "ON" on corresponding standby semistivity monitor.	RF, SDM, and DDM lights "Ox" on corre- eponding rlearance monitor chimicit
	Failure Indications	Control Tait	"ABN"	"ABS"	ABN	"ABN" "MIS- MATCH"
	Fail	Remote Control	MON ABN" and "MAIN"	"MAIN"	"MAN" "MAIN"	ABN" ABN" ABA "MAIN"
	60.1	OCL				
	C	Affer Failure	× .	×	×	
	System Operation	Cat III				×
		Failure Fifert	The staidby coursy monitor recognizes this as being a fail- ure in the standby transmitting unit and, hence, causes the standby unit to be abut down.	Loss of input signal to the standby sen- sitivity, monitor. This, is processed as a fail- ure in the standby ure in the standby transmitting unit, eaveing the standby unit to be shut down.	The standby sensi- tivity monitor re- cognizes this as being a drop in RF power, an iscreas, in SDM, and a de- crease in DDM. The decrease in DDM causes an alarm which, in sturn, shuts down the standby transmitting unit.	Loss of input signal to corresponding clearance monitor chamel, causing a monitor misser. h. Dependence upon re- maining two peak detectors monitors for clearance pa- rameter monit- toring.
		Failure Mode	in orrect 'low) DC output sig- nal.	Total lose of output signal look AC and DC)	Incorrect (low) DC output sig- nal.	Total loss of output signal thoth AC and DC!
Subsystem LOCALIZER STATION		Function		This peak detector receives its input signal from the exambly transmitting unit. After proper attenuation, the input signal is a combinacion of standby course CoSB and SBO. This RF input signal is converted	into a low frequency sig- nal, both AC and DC.  The DC component repre- series the course RF pow- er level; the AC compo- nent is demodulated 90/ 150 Hz signal.	Each of the clearance peak detectors recrives a simulated clearance input signal. This input signal is obtained by a combination of signal cobtained by a combination of signals obtained from both proximity probes and a sampled signal of
OCA!	r.,n	ë. j	5	2		28.
Subayateni	Identification	llen. Name	Standby Course Peak Detector (Continued)	Standby Sen- sitivity Peak Detector		Glearance Parak Detec- Parak Detec- No. 2. or No. 3 (MAIN)

Table C-1. Localizer Failure Analysis (Cont'd)

~ <u> </u>					,	
1'age 15 of 27		Remarks	•	•		
	Failure	Rate (1)		N.B.	6,789 A33A	)33B
	,,, <b>8</b> uo	Other	? ,	RF. SDM.  and DDM  byths  'ON' on  the corre- sponding  clearance  monitor  channel.	RF. SDM. and Dilly lights, nON" on the corre- sponding clearance monitor.	RF, SDM, and DDM ights ights ights sponding sponding sponding clearance monitor.
	Failure Indications	Control		"ABN" and "MIS- MATCH"	"ABN"	"ABN"
;	isi	Remote	2.	"MON ABN" and "MAIN"	. WAAIN" Bad "MAK" "MAKIN"	"MON" ABN" and "MAIN"
~ ,	ation,	r oir	<i>y</i>			
	Ober	r III Cat II			×	×
	System Operation	Cat III		×		
		Failure Fifect	Now dependent upon 1 of 2-, learante moniters for system control.	The collesponding monitor channel processes the failure as being a drop in clearance RF power, an in rease in SIM, and a decrease in DIM.  Now dependent upon I of 2 clearance monitor for system control.	Loss of the inp.t signal to the stand-by clearance mon-itor. This in turn is processed as a fallure in the stand-by transmitting unit coursing the standby unit to be shut down.	The standby clear- give monitor rec- perives this as be- ing a failure in the standby clearance strangulare and, hence, causes the entire standby unit to be shut down.
		f allure Mode		in orrect los. DC output sig- nal.	Total loss of output signal rboth AC and DC:	Incorrect ·low DC output sig- nal,
Subsystem LOCALIZER STATION		Function	tearance C-SB and SBO. This RF input eignal is converted to a low freedown y signal, both AC and IDC. The IDC is representative of the learner RF powerfile AC in the demodalated 44/150 II. the demodalated 44/150 II. thearance signal	Reproduced from Series evailable copy.	This peak detector re- ceives its input aignal from the standby rema- miting unit. After proper attenuation, this input signalis a com- bination of standby clear- ance C-SB and SBO. This RF input signal is	converted into a low ite- quency signal, both AC and DG. The IXC com- ponent represents the clearance RF power level. the AC component is the demodulated 90/150 Hz clearance signal.
200	E CR	i. p	24. 27. 24. 24	oduc evail	33	
Subayatem	Identification	lten. Vame	Clearan e Peak Detec - turs (Continued)	Repl	Standby Clearanc Peak Detector	

Table C-1. Localizer Failure Analysis (Cont'd)

Page 16 of 27		•	ailure occura romica: the redistaly trans-	the I. D. sig- ton-essential tion.		
<b>.</b>	,	Remarks	If another such failure occurs in another I. D. man(ar, the system will immediately trans- fer and then shut down.	Not bazardous _ the 1. D. signal is assumed non-essential for Cat III operation.		
		Rate 6	5.742 (100al) \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	1.050 <sup>3</sup> 34B	1.914 <sup>3</sup> 34C	0.35 0.44 0.44 0.44 0.44 0.44 0.44 0.44 0.4
	1001	Other	I. D. Mon- itor alarm light "ON"		Alarm on standby I. D. Monitor.	
	Pailure Indications	Control	"ABN" and TMIS- MATCH"	(NONE)	"ABN"	(SNOW)
	Fall	Remote Control	"MAIN"	(NONE)	"MON" ABN" and "MAIN"	INONE
	1 con	ğ				~
	å	till Cat II Off	د .		×	
	System Operation	Cat III	×	×		×
	,	Failure Fffect	Loss of 2 of 3 1. D. monitor voting ca- pabulity. Now de- perden, upon 1 of 2. remaining 1. D. monitors for system control.	Loss of 2 of 3 i. D. monitor voting capability. Now de-pendent upon 2 of 2 remaining monitors for system control.	Causes the standby transmitting unit to shut down after a 2-5 sec time delay.	Loss of standby  1.D. algal moni- toriag. Abbugh the I.D. signal is not essential for Cat III operation, this failure mode can be hazardous. If a fauty I.D. signal no occurs on the standby unit after this failure mode, then upon any trans- for command an immediate abatdown will result.
		Fällure Mode	Loss of monitoring chility of one of the main 1. D. monitors, producing an alarm.	Loss of monitoring ability of one of the main I. D. monitors, producing no alarm.	Loss of standby I. D. mon- itoring ability pro- ducing an alarm.	Loss of standy I. D. mon- itoring ability pro- ducing no alarm.
Subsystem LOCALIZER STATION		Function	Each I. D. monitor receives its respective input from the ACC outputs position the itsegral course position monitor channels. Each I. D. monitor checks its input signal for the presence of a keyed tooded audio (1020 Hz) fone. An alan m is produced whenever a loss of audio or keying exists over a definite time interval.		Same as main i, D. mon- itors except it monitore the i. D. signal of the standby transmitter.	
ZVI	lon	.; ş.	**		¥	
Subeyelem L	Identification	Item	identification Monitor Assembly (I. D. MONI- TORS No. 1. No. 2. or No. 31		Identification Monitor Assembly (Sta Aby L. D. Monitor)	

Table C-1. Localizer Failure Analysis (Cont'd)

Pailure	Race (AR'10')	C. 423 Not basardous - I. D. signii A34E assumed not critical for Cat III operation.	0, 137	0.290 <sup>3,3</sup> 4G	, 34Н , 34Н	0,434 Not hanardous - 1/D, signal A341 assumed not critical for Cat III operation.
07.8	Other		I. D. Moss O. 133 itor Ala'm 345; lights will not be lit.	Alarmilghts "ON" on "ON" on "I. D. No. "I. No. "Z. No. "I. No. "Z. No. 3 and standby I. D. montitor.	I.D. abrem lights will not be lit.	
Faifure Indications	Control	(NONE) (NONE)	"TRANS- FER", and "SHUT- DOWN"	"ABN", "TRANS- FER", and "SHUT- DOWN"	"ABN", "TRANS., FER", And: "SHUT- DOWN"	(NONE)
Fa	Remote Control	(NONE)	"MON ABN" and "OFF"	"MON ABN" and "OFF"	"MON ABN" and "OFF"	INONE
tion	Ö		×	×	×	
2	Pailler Cat II	,,	,	Ţ,		-
System Operation	After Failure Cat III Cat II	×				×
	Fallure Effect	that i. D. monitors that main and standby are rendered useless. No alarm are produced and, hence, Cat III operation continues. I. D. signal monitoring is totally lost.	1. D. alarm outpute thoth main and standby) go to a "high" logic level. The control unit processes this as an immediate transfer and then a shutdown.	Alarms on all I. D. monitors, both main and standy), caus- ing an immedite transfer and then a shutdown.	The control unit processes this as an immediate itans- fer and then a'shut- down.	Loss of main 1. D. monitoring ability.
	Fallure	Loss of +12 volts of regulator.	Loss of reg- volts of reg- ulator.	Loss of "12 volts of reg"	Alerm logi causing a main 1. D. alarm.	Alarm logic inhibiting the main 1. D. alarm.
	Function	The I. D. monitor assembly contains the 3 main I. D. monitors and the standby I. D. monitor. A common voltage regulator I-12, -15, -12V) supplies power to all monitors. The Cat III alarm logic Is also contained within	this assembly.			
ç	i. p.	×				
Identification	ltent I	Identification Monitor Assembly (Regulator/ Alarm Logic)			<del></del>	

Table C-1. Localizer Failure Analysis (Cont'd)

Subayatem	V CAL	Subsystem LOCALIZER STATION							;			Page 18 of 27	-
Mentification	tion				System	System Operation	i,	Past.	l'ailure Indications	940	J. Section 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	_
Item Name	1. D.	Function	Failure Mode	Failure Fffect	Car III	After Failife	1 %	Remate	Control	Other	Rate (18 10 )	Reputer	
Ideriffication Monitor Assembly (Regulator) Alerni Logici	*		Alarm logic inhibiting the main I. D. alarm.	Shutdown of stand- by transmitting unit:	(	×	7 4 7 7	ABN" ABN" And "MAIN"	'ABN''	Stby I. D. alarm Matrim Mot may or may not be lit.	0. 172 <sup>A</sup> 34J		
Continued			Alarm logic inhibiting the standby I. D. alarm.	Loss of standby I. D. monitoring ability.	×		8	(NONE)	(NONE)	  	0.242 <sup>1</sup> 34K	des, of the contract of the co	
			Alarm logic causing a mismatch.	No serious effection- system since a mon- itor mismatch does not effect Cat III operation.	×	,	: < #: ,	MAIN"	"MATCH" and "ABN"	No mis- match on monitor channels	795 <sub>X</sub>	Not hazazdous.	
Changeover and Test Cir- cuite (Pask Detectors Excluded)	21	The changeover and test circula provide the automatic changeover capbility for the redundant transmitting units. It seems to control unit from the control unit which transmitting unit radiates into the automate and which unit operates into dummy loads.	Inability to changeover transmiting units by switching circuitry.	Although this failt- use mode does not immediately effect system operation, the does jeopardize Cat III status. This is due to the fact that any failure on the main unit, which should only generate a changeover to standby, will result in a system shut- down.	×	, i	2	(NONE)	INONE)		1,22,4	Essentially renders the stander by utilt uncleus,	
			Fremature transfer of transfering units to astemas by switching circuitry.	If in MAIN, a trans- fer to STANDSY will occur: If in STAND- BY, a transfer to OFF will occur. This is due to a momentary lose of signal.	,	X (4.8-1 ing initial MAIN STATUS)		ABN: ABN: STBY:	"TRANS- "TRANS- FER"	Alarms oc 0.134 some montior channely,	7, 128 128	Escentially remores either the main or standby transmittor useless.	

Table C-1. Localizer Failure Analysis (Cort'd)

Page 13.01 22.		Remarks	faltire.			ang chaireace tilligie gatie. ang chaireace tilligie gatie.	is should be need that since any signal degradation sufficient to be 'out of Cat III tolerance' has the 'vame net effoct, all possible failu's modes may be treated on an aggregate basis.  ij ja's the failure rate of the credity required for signal radiation. Le, up to and including the antennas.
	Fallure	Rate (Ax 10°)	0.782 <sup>1</sup> 12C	0,070 A12D	0.070 A12E		0.859 713 713 0.509
	•uc	Orbei	Abrm(s) on respec- tive stand- by monitor channel.	Alarms on sensitivity monitor channels.	Alarms on clearance monitor channels.	Abrims on 27,417 From Scool N2F Heye chant, (Total) nels.   172   127	the sensi- tiyity and/ or course mynitor channels.
	Fallure Indications	Control Unit	"ABN"	"ABN" and "TRANS- FER"	"LBN" and "TRANS- FER"	"AEN"; "ThANS- FER" and "SHUT- DOWN"	"ABN", and "SHUT- DOWN", TRANS- "TRANS-
	Fall	Remote	"MON ABN" and "MAIN"	MON ABN" and "STBY"	"MON ABN" and "STBY"	ABN" AEG	"MON ABN" and "OFF"
	Atton	50				×	×
	System Operation	III Cat II	×	×	×		
į	Syster	Cat III Cat II		<u> </u>			
		Fallure Fifect	The slarm on the standby monitor will shutdown the stand-the main unit continues to operate cormally.	Alarms on monitor channels initiate a transfer to standby and system operates on standby.	Alarms on the clearance monitors initiate a transfer to standby and system operates on claribly.	Immediate ahutdown after an automatic transfor.	Since a failure of this type is inde- prodent of the trans- mitting unit, an im- médiste shutdown after an automatic transfer will result,
		Fallure Mode	Failure causing a lose (or in- correct) signal to one of the stand- by monitors.	Total loss (or incorrect phasing) of course SBO signal of the main transmitting unit.	Total loss for incorrect phasing) of clearance clearance SMD signal of the rasin transmitting unit.	Loss of any one or all of. CSE CoSB. CCT SBO. CL SBO. (to main transmitter)	A total loss of signal for any signal for any signal path; incorrect phasing of either the radiated signals or the detected signal; dien salifier.
LOCALIZER STATION		Function					The course distribution circuits zerve two primary functions: (1) to route and distribute the course C45B and SBO signals to the antennas: (2) to construct by use of proximity probes, bridge networks and phase shifters the sig-
OCALL	٤	.; .;	22				2
Subayatem LOCAL	Identification	Name	Changeover and Test Cfrants (Continued)				Course Dis- tribution Ckts (Peak Detec- tors, Excluded)

Table C-1. Localizer Failure Analysis (Cont'd)

Fame   E.D.	티	ZVI ZVI	Subsystem LOCALLIER STATION										PART 20 of 27	
13 Course width, percent cause monitoring from the course width the control of the course width the	in the second	É		:		System	Operati		Fall	ure Indication	suc	Failure		
modulation, and RF (i.e., out of percent corresponding to the control of percent corresponding to the correct		2	Function	Mode		Cat III	Cat II	ĕ	Control	Control	Other	Rate (1)	(	
the three celestrees electrical to receive the control of the celestrees electrical to receive the celestrees electrical to receive the celestrees that the celestrees		13	course width, percent modulation, and RF power.	tor alarms, i.e., out of Cat. III tol-	·				,					
the signal for monitoring A loss of Since the SDM is the signal for monitoring and building and building percentage, and or pf. (ii) DDM to perovide and signal fluids and sig	หูเมื่	*	The clearance distribu- tion circuits perform two functions: (1) to reads and distribute the clear- ance C45B and SBO sig- nals to the antenas; (2) to construct, by uning the signals obtained by prox- imity detector probes.	A love for major dis- torti(a) of signal for any clear- any clear- ance signal path.	Upon failure; an immediate transfer followed by an immediate abutdown will occur. This is due to the fact that the circuitry is common to both transmitting units.	,		<del></del>	Z	"ABN" and "TRANS- FER" and "SHU"- DOWN"	<del></del>	1.032 <sup>3</sup> 34A	SDM, DDM, and/or RF slarms on the monitors are dependent upon specific failures.	1.
The two battery chargers. Loss of When one charger X Down. "PWR/ "ASN" "Charger 10.477 which are sessetially in charges out-fails (total loss of partelled, supply all the equipment of the localiaer station (The far field mon-gapelies the new power to the state own power to the supplies the new power to the new po				A loss of signal (trus) or part (si) to nea. (field peak detectors.	Since the SDM is strapped with the DDM to provide an alarm, a shudown will result after the nominal delay. Note that a shutdown alert will also be generated.				Z: į̇̀	"ABN" and "SHUT - DOWN"		0.040	It should be nized that the near field signal power divider and peak detroiors are within the clearance distribution box.	1
		2 1 9 1		Loss of charges out- charges out- pur volume. (Note: the  monthal out- pur voltage  is 30 volts DC)	When one charger fails (total loss of output voltage), the remaining charger supplies the necesary load voltage and current to confine normal operation. It also will supplies the voltage to maintain full charge on both beterries.	7	Down- grade to Cat to Cat to Cat to Cat to Cat to Cat	·	IN.	ARG-	L #	N.A.	Not beardons - redundancy of retraining charger and the two batteries provide segligible probability of station abusdowns.	1

Table C-1. Localizer Failure Analysis (Cont'd)

Pake 21 of 27		rks 	both trans- allable after	a total dis- titaries can: the system atteries for pariod of time Bours). Sys- n batteries is n batteries is n patteries is n	mest fail.	both trans- silable after
α.		Remarks	Not bazardove - both trans- mitters still available after downgrade.	Not bazardous - a total dig- charge of the batteries can cour only after the apstem is operated on batteries for a some stranded period of time (greater than 3 bours). Sys- tem operation on batteries is a result of either primary or a failure of obth chargers - both of which would downgrade performance to Grill.	To result in a station shutdown both convertors must fall.	Not basardous - both trans- mitters still available after downgrade.
į	/ailure	Rate (1)	0.801 NAB	, Mnc	N, N, S,	۵۰، نوم ۱۹۶۸ ۱۹۶۸
2	one	Other	"Charger fall" and/ or "ac power fall" light "on" on respec- tive charg- er.			,
Í	Failure Indications	Control	"ABN" and "CHARG- ER FAIL" and/or "AC POW-	(NONE)	"ABN" "CON- VERTER FAIL"	"ABN" and "TEMP"
	Fall	Remote Control	"PWR/ ENVIR ABN" and: "MAIN"	(NONE)	"PWR/ ENVIR ABN" abd' ("MAIN"	"PWR/ ENVIR ABN" and "MAIN"
	tion	orr		·		<u></u>
	o do	r III. Cat II	Down-grade to Cat II af- ter time delay.		Down-grade to Cat II af- ter time delay.	Bown- grade to Cat ii af- ter ter time delay.
	System Operation	Cat III,	×	×	×	×
		Fatlure Evect	No immediate effect on system opera- tion - after the pre- set time delay the  system will be  falsely downgraded  to Cat II status.	With the loss at the equalite capability on one charger, the remaining charger can still provide the equalite capability as long as the batteries are not tecally discharged.	Station maintains normal operation on remaining converter voltages. Each of the converter voltages is sensed in the control unit for abnormal tolerances.	System maintains normal operation - only an erroneous failure indication,
		Sallure Mode	Charger fallure in- dication only while output voltage is still main- tained on both charg- ers.	Loss of equalize voltage capability - pability - leither manual and/or avomatic. Note: the equalize voltage is a nominal 33 volts dc. thus providuing a "hard charge" in the batteries	Loss of any one or all of the following voltag:- +5.5v18v.	Failure producing an alarm indication.
Subsystem LOCALIZER STATION	-	Function	In the event of a primary power failure the two batteries (in parallell supply the necessary de power.		Each of the DC/DC converters transfroms the 400 votes nominal input voltage to three different output voltages - 45.5v, -18v, and -50v. The output voltages of each converter are respectively used in parallel and feed both modulators in the system.	The temperature acraors provide alarm indications whenever the temperature exceeds or drops below the are set to give indication of air conditioner/
LOCAL	lon	ľ. D. %».	15 01 16		113	62
Subayetem	Identification	ltem Name	Battery Charger No. 1 or No. 2 (Contirued)		DC/DC Converter No. 1 or No. 2	Temp Sensors

Table C-1. Localizer Failure Analysis (Cont'd)

Page 22 of 27		Remarks	Not bazardous - if temperatura effects system operation, other alarms will occur.	Not besardous - both trans- mitters still available after downgrade.	Redundancy/as been incorporated in the design to minimise the failure mode probability of occurrence.	Since this failure mode can lead directly to a shudown withour a Cot III disable, it is basardous.
	Failure.	Rate (Ax 10 <sup>6</sup> )	00 m	0. 676 <sup>3</sup> 49.A	0.874 2.98 0.102 0.530 0.262	2,512 7,49 C
	one	Oher				
	Failure Indications	Control	(NONE)	(NONE)	:NONE)	"SHUT- "SHUT- "SHUT- BDOWN", BDOWN", FIELD SHUT- DOWN"
	Fai	Remote Ceatrol	( KONE)	None exy (NONE) cept "Cat III" after time de-lay.	(NONE)	ABN's and 'OFF's
٠	ation	2 2				×
	System Operation	After Failure		Down- grade to Cat If af- ter time delay.		
	Systen	Cat III	×	×	×	
,	,	Fallure Effect	There are two sen- one (or high temp- eratures and one for low temperatures. A fallure of this type in one of the sensors operation of the tother. Heace, the operation of temp- inoring ability for only one tempera- ture extreme (high or low).	No effect other than Islaely disabiling Cat III status at the remote control tow-	Inability to recog- nias far field Cat III "out of tolorance" conditions.	After a nominal 70 second time delay, the emite localizer station will shot-down. Five seconds prior to shutdown alert (afgrafi. rediated.
		Fallure Mode	Failure producing no alarm in- dication.	Generation of an erro- neous Cat III disable signal.	Inability to generate a Cat III dis- able signal.	Generation of an error- neous Cat II monitor alarm.
Subsystem LOCALIZER STATION		Function	heter fällures.	The combining circuits assembly of the far field monitor processes the slarms of the monitor channels, the DC/DC convertors, the battery charger, and a tempela-	ture staten.  Cossing includes the time delays necessary for far field monitor chamel alarme.	
COCAL	ion	. š.	61	<b>\$</b>		
Subsystem	Identification	Item Name	Setsore (Continued)	Combining Circuite		

Table C-1. Localizer Failure Analysis (Cont'd)

Identification	Mon				System	System Operation	Ę	E	Failure Indications	***	1	
item Name	1. p. No.	Function	Fallure Mode	Failure Effect	Cat III	After Fathere	Ĭĕ	Remote	Control Unit	Other	Rate (Ax 106)	Remarks
Combining Gircuita (Continued)	6‡		Generation of a shut- down alert only.	No effect on system operation - only a false shutdown warn- ing signal is gener- ated.	×			(NONE)	(NGNE)		0,514 A49E	Not hazardous - only psycho- logical implications.
		•	Generation of a shut- down signal. (No warning)	Jumediate shutdown of the entire focal- ter station with no warning signal gen- erated prior to shut- down.	•	,	×	"MON ABN" and "OFF"	"ABN", "SHUT- LOWN" and "FAR FIELD SHUT-		0.525 <sup>3</sup> 49E	
			Inability to process a Cat II mon- itor alarm.	Loss of Cat II far field monitoring capability, Cat III disable signal still processed normally.	×			(NONE)	(NONE)		3.986 A9F	Not hazardous - Cat III far field monitoring still avail- able.
			Jability to process a shutdown alert.	Loss of shutdown warning capability to pilot prior to shutdown due to a "true" far field alarm.	×			(NONE)	(NONE)		1.214 49G	Not bazardous - shutdown warning not vital to system operation.
			Generation of an erro- neous mis- match sig- nal.	Only the input gat- ing circuitry may be hazardous; mis- match conditions in themselves are not.	×			"MON AEN" and "MAIN"	"ABN" and "FAR FIELD MONITOR MIS- MATCH"		0.621 \49H ((cda)) \49HI * 0.213	Only 49Hl (input gates) effect actual monitoring circuity which can be hatardous.
			Inability to process a mismatch condition at the FFM.	No acrious effect on system - alarm attus conditions are alli processed normally.	×		, , , , , , , , , , , , , , , , , , ,	(NONE)	(NONE)		1.476 '	Not basardous - mismatch conditions do not effect Cat, Ill performance.

Table C-1. Localizer Failure Analysis (Cont'd)

	1		1		1	l. Y
Page 24 of 27		Remarks	Not hasardoge - well cans- mittors of il availably after downg/ade.	Not besardous:	Not hazardous - If power or temp do effect far field monitor performance, the monitors will alarm.	,
	Patther	Rate (hx 10 <sup>6</sup> )	0.397 <sup>1</sup> 49J	0.436 <sup>3</sup> 49K	0.852 \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	0.690 7.694 7.694
	eno	Other	A power or 0.397 temp light Agy may or may not be "on" at fifm.	"remp" "ight at the ffm.		AL FFM no 0.690 power or hapk temp displayed. Monitor Monitor vill alarm after shute ( down.
	Failure Indications	Control Unit	"ABN" and "FAR FIELD PWR/ TEMP"	(NONE)	(NONE)	"ABN"; "SHUT- "SHUT- DOWN"; "FAR FIELD SHUT- SHUT- FAR FIELD MATCH"; "TAR FIELD PWR/ TEMP"
	E.	Remote Cot. 201	"POW- ER/ ENVIR ABN" and	(NONE)	CHONE	"MON", ABN", FPWR/ENTRABN" ABN" and "OFF"
,	ion	Ö			,	×
,	Opera	After Fallu/e	Down- graded to Cat II af- ter time dclay.			, , , , , , , , , , , , , , , , , , ,
	System Operation	Cat III	×	×	×	
	,	Failure Effect	System falsely down- graded to Cat II status after a act time dulay.	No effect on system oppration whatso- ever - only a false light "on" at far field monitor sta- tion.	Loss of per/temp monitoring ability of the far field monitus.	Immediate shutdown of the emire local-last station of the cursed by the generation of a shutdown signal from the far field monitor.
		Fallure Mode	Generation of an erro- usous pwr/ temy alarm.	Generation of an erro- neous pury / temp alarm that is dis- played only locally.	Inability to process a pare/temp alarm for either remote or local display.	Loss of de output voil- age on +5w regulator.
Subsystem LOCALIZER FAR FIELD MONITOF		Function				
ALIZE	ron ton	. v.	49			
Subeyatem LOC	Identification	.ttem Name	Companie Circuite (Continued)			

Table C-1. Localizer Failure Analysis (Cont'd)

Pake.25 of 27		Remarko	Not barardous - l'oth tratis- mitters still available affer dowigrade. NOTE Design changes provided down- grade capability.	ξ	Not bazardous - both converters still operational after downgrade.		Note failure mode, has the same effect as an ifm hattery failure.
	Patters	fate (\x 10 <sup>6</sup> )	0, 095 <sup>3</sup> 49N	2.412 <sup>3</sup> NÅ	0.050 ANB	5.790 °	0, 519 <sup>3</sup> 50B ←
	ons	Other	<u> </u>	"CONV FALL" light "on" at FFM.	"CONY FAIL" light "on" at FFM.	"Charger FAIU" light "on" at FFM	
	Fallure Indications	Control	(NONE)	"ABN" and "FAR FIELD PWR/ TEMP"	"ABN" and "FAR FIELD PWR/ TEMP"	"ABN" and "FAR FIELD PWK/ TEMP"	(NONE)
1	Fall	Remote	None ex- cept "Cat II" after time de- lay.	"PWR/ ENVIR ABN" and "MAIN"	"PWR/ ENVIR ABN" and "MAIN"	"PWR/ ENVIR ABN" *nd	(NONE)
	i c	ă	7,3				
:	System Operation	After Fallure	Down-grade to Cat II af- ter time delay.	Down-grade to Cat II af-ter time delay.	Down- grade to Cat 31 af- ter time delay.	Down- grade to Cat II af- ter time delay.	
	Systen	Cat III	×	×	×	×	×
		Fallure Effect	fability to turn on far flelc monitor channels, hence, losing al; far fleld monitoring capabil- ity.	System maintair operation on remaining converter. If the remaining converter also falls, the localizer station will be shut down, due to momitor channel alarms.	System falsely downgraded to Cat II status after a set time delay.	System maintains operation on far field monitor bat-tery.	If another failure of the battery charge- er causing loss of "24" occurs, im- mediate abutdown of the localizer station will result.
a		Fallure Mode	Loss of monitor en- able signal.	Loss of -18 volts output.	Generation of an erro- neous con- verter fail alarm.	Loss of +24 volts output.	"Low voit- age" battery age" battery circuit fail- ure, discon- meeting the battery from
System SSIIS Subsystem LOCALIZER FAR FIELD MONITOR		Function		Each of the DC/DC converters of the far field monitor provides -18v, used in the monitor channels and the receivers. They are in parallel and isotated by diodes.		The battery charger supplies a - 45 volis to each of the units at the Livifield monitor - the two convertes, the three receivers and their respective monitor clannels, and	the combining circuits assembly. The battery charge on the battery at all limes.
SSILS	u o	I. D.	49	15 S S S S S S S S S S S S S S S S S S S	——, ——————————————————————————————————	20	
System SS Subsystem LOC.	Identification	Item Name	Combining Circuite (Centinued)	DC/DC Converter No. 1 or (FFM)	,	Battery Charger	

Table C-1. Localizer Failure Analysis (Cont'd)

	<b>.</b>		,	1		1	1
Fare 26-01 27		Ferance.	Net hazardous - "quiek charge" capability does not directly effect monitoring performance.	Not hazardons - far field monitoring not effected,	Not hazardous - preventive maintenance required for buttery check,	The SDM strap option provided renote recognition of Sallare.	Not hazardous - far field Cat Ill monitoring cannot lead to a shutdown, only a performance' degradation.
		Rate fox 10'.	0.316 ^50C	0, 126 0, 0,0	7.656 50E	£9. ½.	0.825 NAA
	ons	Caber	,	"Charger FAIL" light on at FFM,		RF/End   0.6 SDM lights \N. SDM col. on the col. respectable monitor channel.	, 
	Failure Indications	Confeed Pair	(RONE)	"ABN" and "FAR FIELD PWR/ TEMS"	NONE	"ABN"  *** *** *** *** ** ** ** ** ** ** **	(NONE)
	Ĺ,	Contr	INONE	PWRI ENVIR ABN' and "MAIN"	130NE1	"MON ABN" Pard "WAIN"	(NONE)
	Strub.	Father Cat II Off				· · · · · · · · · · · · · · · · · · ·	
	System Operation	After Failure		Sown- gradz to Cat II af- ter time delay.			
	Syator	Cas III	×	×	× ^	×	×
-		Failure Fife-t	Does not effect sys- tem operation. A trickle charge will still be applied to the battery.	System falsely domngraded to Cat II stylus after a set clivie delay.	Far field monitor maintains normal operation at a slightly higher sup- ply voltage.	Loss of the input signal to the corresponding far field monitor charmed will produce a FFM monitor weight. Loss of 2 of 3 FFM monitor weight, Now depublish, Now dependent upon 1 of 2 remaining menitors for system opera-	Loss of 2-of 3 mon- itor the Cart III alarma. Now depen- dent upon 1 of 2 remaining monitors for Cat III perfor- mance status.
		Failure Mode	Loss of equalize tharge ca- pability af- ter a power	Generaliton of an exco- neous civere er fail alarm	Contistons equalize voltage only.	Total loss of output of suput output major signal distortion.	Loss of monitoring ability, pro- ducing a Cat III DDM alarm.
Subsystem LOCALIZER FAR FIELD MONITOR	,	Function				Zach of the far field mon- itor receivers receives at low level of lipput sig- nal and converse it to the its sudio and of eighal which is then the unput to the respective moultor thannel. The DDM of the andto oignal in rypre sensative of the far field course position.	To provide monitoring of the course position in the far field region of the tenway. It provides both Cat III and Cat II alarm limit monitoring.
CALIZ	thon	1. p.	85			<b>ಬೆ</b> ಸೆ ಕಪ	3.5.92
Subayatem 1.0	Identification	ltem Kame	Battery Charger (Continued)			Raceiver No. 1, No. 2, or No. 3	Monitor Chambels No. 1, No. 2, or No. 3

Table C-1. Localizer Failure Analysis (Cont'd)

Page 27 of 27		Remarks	A Category III DDM alarm may or may not be produced.	Note that this failure mode applies to either or both Cat III or Cat II DDM alarms.	Not bazardous - far field monitoring still available after downgryds.	Not bazardous - if temperature effect monitoring, alarme will occur.
	Failure	Rate (Ax 10 <sup>6</sup> )	11.099 NB	4.422 NO V	0.050 <sup>3</sup> 59.A	0.050 8654
	suo	Other	DDM light "on" at FFM.		Temp 0.050 alarm light \bgs. 100" at FFM.	·
	Failure Indications	. Control Unit	"ABN" 2nd "FAR FIELD MONITOR MIS- MATCH"	(NONE)	"ABN" and "FAR FIELD PWR! TEMP"	(NONE)
	Fai	Remote Control	ABN" ABN" And "MAIN"	(NONE)	"POW- ER/ ENVIR ABN" ABN"	(NONE)
-	tion .	Orr				
	Opera	After Failure		<u>.</u>	Down- grade to Cat II af- ter time delay.	
	System Operation	Cat III	×	×	×	×
		Fallure Fifect	Loss of 2 of 3 mon- itor voting capabil- ity. Now dependent upon 1 of 2 remain- ing monitors for system operation.	Loss of 2 of 3 mon- itor voting capabil- ity. Now dependent upon 2 of 2 remain- ing monitor for far field monitoring.	System falsely downgraded to Cat Il status after a set time delay	Loss of temperature monitoring ability without recognition.
		Faikure Mode	Loss of monitoring shilty producing Cat II DDM slarm.	Loss of monitoring ability producing no alarms.	Generation of an erro- neous temp. alarm.	Inability to produce a termp.
Subsystem LCCALIZER FAR FIELD MONITOR		Function			Monitors the tc::.percture of the FFM for out of tolerance conditions.	
ALIZ	ion	f. D. No.	56. 58 58		65	
Subeyetem LCC	Identification	Item Name	Monitor Chamels (Continued)		Temp. Sensor	

Appendix D
Glideslope Failure Analysis

## Appendix D Glideslope Failure Analysis

This appendix, referred to in section 7.0, consists of the failure analysis for the glideslope, as shown in table D-1.

Table D-1. Glideslope Failure Analysis

Subsveten	CLIDES	Subsystem GLIDESTOPE STATION									Page 1 of 18
Identification	lon.			,	System Operation	peration	l'ail	Failure Indications		Pailure	
Iten: Name	ë ;	Function	I ailure Mode	Failure Fifter	Cat III Cat II	Car II Off	Remote	Control	Other	Rate	Remarks
mitter (MAIN or STANDBY)	ន្ទន្	The course transmitter in conjunction with the IO wast amplifier delivers a UTIF carrier to the modulator.	Loss or de- gradation of l'HF carrier.	Loss of all course signal radiation, effecting the endire glidepath angle and width.		×	MON ABN and STBY	"ABN" And TRANS- FER'	Alarms on course, sensitivity and near field monitors.	6.734 NN	Failure of standby unit keeps standby down.  NOTE Although near field monitor lights are "on", their alarms are not processed.
Clearance Transmitter (NAIN or STANDBY)	2 2 8	The clearance trans- muter supplies a UHF carrier modulated at 150Hz which is used to ensure low approach	Loss or de- gradation of the 150Hz modulation.	loss of clearance coverage of approach angle. (Pure carrier radiated)		, ,	MON ABN j nd STBY	ABN' ând 'TRANS- FÉR	"SDM AND DDM" lights on clearance monitors.	1.914 NA 1	Failure of standby unit keeps ' main" operational and shuts standby down.
			loss or de- gradation of UHF carrier-	Intent clearance coverage of approach angle.		×	MON ABN and STBY	ABN' and TRANS- FER"	SDM". "DDM". AND RF' lights on clearance monitors.	6.734 NB	
10 Watt Ampli- fier (MAIN or STANDBY)	05 03	The 10 watt amplifier merely amplifies the course UHF carrier.	loss or de- gradation of UHF carrier.	Loss of all course signal radiation.	-	×	"MON ABN" And "STBY"	"ABN" and "TRANS- FER"	Alarms on course. sensitivity. and near field moni-	0.686 <sup>A</sup> N	Fallure of standby unit keeps "main" operational and chute standby down.
Modulator (MAIN or STANDBY)	03 07	Provides course !!!!F carrier amplitude modu- lated by a 00H; and 10H H signal, GSE 6-SB, II provides the course SBO signal; a low frequency 150Hz signal which feeds the clearance trans- mitter.	Inse of low frequency os- zillator (14.4 kHz) result- ing in loss of all 90Hz and 150Hz modu- lation.	inss of the follow- ing system signals: 1. LF 150 2. SB in clearance C+SB 3. Course SPO 4. SB in course C+SB		×	"MON ABN" End "STBY"	"ABN" and "TRANS- FER"	Alarms on all course. sensitivity. near field, and clear- ance moni- tors on main cabinet.	2.613 <sup>λ</sup> NA	"Transfer" would not occur on failure of standby unit. Loss of Cat. Ill status would occur even though "main" is still operational.
			Lose of UHF carrier to digital phas- ing ckts. (to either or both of the 90 and 150 phase shifter	Loss of SB in course C-SB signal and course SBO signal;		×	ABN" and "STBY"	"ABN" and "TRANS- FER"	Alarms on all course sensitivity, and near field moni- tors.	0.427 <sup>A</sup> NB	

Table D-1. Glideslope Failure Analysis (Cont'd)

Subeyetem	1011	Subsystem SIDESLOPE STATION			,							Page 2 of 18
Identification	tton				System	System Operation	يا	Fallu	Fallure Indications	Jue Jue	To thus	
ltem Name	 	Function	Fallure Mode	Fallure Effect	Cat III	t III Cat II OII	L	Remote	Control	Other	Rate Ax 106)	Remarks
Modulator (MAIN or STANDBY) (continued)	8 # 6		Less of 90 or 150 Hz div- iders, syn- chronization circuity or 90/150Hz shift regis- ters.	Out of tolerance course C4SB and SBO and clearance C4SB signals.	/	*	<u> </u>	MON ABN: STBY:	"ABN" and TRANG. FER"	Alarme on all course, sensitivity, near field and clear- ance moni- tors.	1.453 \NC	
			Loss of \32 driving signal to delay line feither the 90Hz or 150 Hz phase shifter).	Siight distortion of the course C+SB and SSO signals.	×	)	<del></del>	NONE	NONE		2.426 \ND	Not-hazardous-signal still within Cat. III tolerance.
			Loss of \16 driving signal to the delay thes (either the 90 Hz or 156 Hz phase shifters).	Distortion somewhat I more than A <sub>32</sub> of the course C+SB and SBO signals.	×	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	<u> </u>	NONE	NONE		2.426 ^NE	Not-barardous-signal still within Cat. III tolerance.
	المعارفة المستوادين المستوانين والمستوارين والمستورين والمستوارين والمستوارين والمستوارين والمستوارين والمستوارين		Loss of As.  A: A:  A: A:  Signal to the delay line.  Gethor the  Office of 150.  He phase  shifters!	Out of tolerance course C+SB and SBO signals.		×	•	ABN" And STBY"	"ABN" and "TRANS- FER"	Alarms on all course, sensitivity, and near field monitors.	12.832 NF	, <u>.</u>
			Loss of 490, -90, 4150, or -150Hz phase shifter RF signal.	Out of tolerance C45B eignal,		×·	<u> </u>	ABN". STBY	"ABN" and "TRANS- FER"	Alarms on all course. sensitivity. and near field moni- tors.	1.302 NG	

Table D.1. Glideslope Failure Analysis (Cont'd)

System SSI Subsystem GI.	105.5	SSILS GLIDESLOPE STATION								<		Page 3 of 18
Identification	ų				System	System Operation	Ę	Failure Indications	dications		Failure	
Item I	.; .;	Function	Failure Mode	Fallure Effect	Car III	till Cat II C	Off Control	ote Control		Other	Rate (Ax 10)	Remarks .
Modulator (continued)			Lass of the 150Hz sinu- seridal signal for clearance transcrission.	Out of tolerance clearance C+SB signal.		×	ABN' ABN' STBY'	<del></del>	 	me on lear- moni-	3.7.76 N.W.	
Course Moni- tor Channels (1, 2, or 3) (MAIN)	# ¥ \$ #	Previde monitoring of the course position path angle (*DNI), the "modulation (\$DNI) and the course I'll power level.	loss of moni- foring ability- producing alarms.	Loss of 2 of 3 moni- tor voting capability. Now dependent on 1 of 2 remaining moni- tors for avatem	×	<del>`</del> ,	MON ABN and MAIN		.:	2 % 5 2	12.689 1.NA	If another corresponding monitor alarm failure occurred in one of the remaining two monitors, immediate glideslope shutdown will result.
			lots of moni- foring ability, producing no alarms.	Inss of 2 of 3 moni- tor voting capability. Now dependent upon 2 No dependent upon 2 of 2 remaining monitors for system	×		NONE	: NONE	ri,		4.836 \NB	•
Course Moni- tor Channel (STANDBY)	¥	Same as main course monitor channels except moaltors course para- meters of standby unit.	loss of moni- toring ability, producing alarms.	of moni. Shutdown of standby ability, transmitter, ring	,;;	х	MON ABN and MAIN	MON ABN ABN ABN And		on r.	12.689 \46A	
			Joss of moni- toring ability, prodecing no	Loss of standby course nonitoring.	×		NONE	E NOVE	E .		4.836 \46B	7
Sensitivity Monstor Channels 1, 2, or 3 (MAIN)	5 4 5 5	Provide monitoring of the the course width (DDM)	Loss of moni- toring ability. producing alarnis.	loss of 2 of 3 moni- tor voting espability. Now dependent upon No dependent upon 1 of 2 v. musining monitors for system control.	×		MON ABN and MAIN		.1	i i en	7,367 \XA	If another corresponding moni- tor DDM failure occur red in one of the remaining two moni- tors, intrediate glideslope shurdown, ill result.
			Loss of troni- toring ability- producing no (Jarms,	loss of 2 of 3 moni- for voting capability. Now dependent upon . 2 of 2 remaining monitors for system control.	×		Now	E NONE	ш		2,802 'NR	'Only DDM monitoring circuitry is critical.
<del></del>			\ <u>&amp;_</u>	Reproduced from y.			<del></del>		<del></del>	<del></del>		
			ני	\								

Table D-1. Glideslope Failure Analysis (Cont'd)

Cat II   Off   Control   Unit   Other   (Az 106)	Identification					System	System Operation After Failure	Ę,	15	Silvre Indications	,	Failure	Page 4 of 18
X NONE NONE NONE 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	1.D. Function Fallure Fallure Fifeet	Function Fallure Mode		Fallure	Fifeet	Cat III	11 10	Ę	Permote	Control Unit	Other	Rate factor	-
X NONE NONE 11.000  X MON "MONI- Alarm 11.000  ABN TOR MIS- lightis) on ANA  AATCH defective NO  AANIN" ABN" mar field NA  X NONE NONE NONE NO  AANIN ABN" Alarm 13.044  ABN" ABN" MATCH defective ANA  AANIN ABN" MATCH defective ANA  AANIN ABN" Alarm 13.044  ABN" ABN" Alarm ABN  ABN" ABN" Alarm ABN  ABN" ABN  ABN  ABN  ABN  ABN  ABN  ABN  ABN	47 Provide monitoring of the loss of moni-Shutdown of the standby course width toring ability standby transmitDMs.  producing alarma.	Provide monitoring of the loss of moni- standy course width toring ability (DDM), producing alarma.	it y	Shutdown standby tr	Shurdown of the standby transmitter.		×	,	MON ABN and "MAIN"	ABN"	Alarm lightis) on standby sensitivity monitor.	474 A	
X 'MON' ''MONI- Alarm 11.000 Ans TOR MIS- lighties on ANA TOR MATCH' defective and MATCH' defective and MATCH' defective and MATCH' defective ANA TOR MATCH' ANA	Loss of moni- Loss of standby toring shillity course monitori producing no slarms.	moni- illity f. no	moni- illity f. no		Loss of standby course monitoring.	×	Ì	4	NONE	NONE		2.802 <sup>3</sup> .47B	
X NONE NONE SI'REZ  X NON "MONE NONE SI'REZ  X NONE NONE SIGNATOR  X NONE NONE SIGNATOR  X MAN" "ABN" Algern  X ABN" Algern  X ABN	43. Provide monitoring of the Loss of moni-Loss of 44. near field course position ability tor voting or tion path angle (DDM) producing 304 dep 45 alarms. 10 2 remonitor.	Provide monitoring of the Loss of moni- ness field course posi- tion path angle (DDN) - producing alarms.	is of moni- ing ability ducing rms.		toss of 2 of 3 moni- tor voting capability. Now dependent upon of 2 remaining monitors for system control.	×	<u>;</u>		"MON" ABN and "MAIN"	"MONI- TOR MIS- MATCH" and	Alarm Ifght(s) on defective near field monitor.	11.099 <sup>k</sup> NA	SDM and DDM are strapped to provide one general alarm output.
X NON "MONT Albern 13.044  AEN" HATCH" defective ANA  AEN" ABN" ABN" ABR 13.044	Loss of mon! Loss of toring ability tor votin producing no Novidep alarms. 15.2 re alarms. 10.01001				Lose of 2 of 3 moni- tor voting capability. Nov. dependent upon Nov. dependent upon 2, 2, 2 remaining monitors for system control.	×			NONE	NONE		3,872 VNB	
X NONE NONE  NONE NONE  X "MON "ABN" Alarm 1  ABN" Alarm 1  ABN ALARM	40. Provide monitoring of the Lobs of mond Loss of 2 of 3 model. Clearance DDM, % mode toring ability (or voting capability or ulation, and clearance producing Now dependent upon the lot of the lot	Provide monitoring of the Loss of moni- clearance DDM, % mod- toring ability ulation, and clearance producing UMF power level.		Loss of 2 tor voting Now depe 1 of 2 restrontors control.	Loss of 2 of 3 mont- tor voting capability. Now dependent upon 10 f 2 remaining monitors for system control.	<b>×</b>		`	AEN' AEN' and "MAIN"	MATCH"	oo n	13.044 NA	If another corresponding mentor slarm failure occurred to each of the remaining two mentors, immediate glideslope shusdown will result.
ABN" ABN" Alarm II ABN" Alarm II and chamby "MARN" Clearance monitor.	Loss of moni. Loss of por lor voti producing Now Jest producing Now Jest producing Now Jest producing alsern. Z of Z g producing control.	ž t	ž t	Loss of tor woth Now dep 2 of 2 re monitor control.	Loss of 2 of 3 moni- tor voting capability. Now dependent upon Now dependent upon 2 of 2 yemsling monitors for system centrol.	×			NONE	NOME	,	4.848 3.83	
	48 Same as Main Clearance Lose of monly Shutdown of Monitor Channels except toring ability it is namitter. mondrater clearance producing parenteres of stundby alarm.	Samwww Main Clearence Lose of monly Monitor Channels except foring ability months of clearence producing parimeters of standby alarm.	12 12		Shutdown of standby	<b>*</b>	×		"MON ABN" and "MAIN"	"ABN"	Alarm Light(s) on standby clearance monitor.	13.044 <sup>3</sup> 48A	

Table D-1. Glideslope Failure Analysis (Cont'd)

Page 5 of 18	*	Remarks	
	flure	Rate () R	4.4 8 8 8 4 8 8 8 8 8 8 8 8 8 8 8 8 8 8
		Other	<b>→</b> **
	Failuse Indications	Gontral Unit	NONE ,
,	Fallu	Remaie	NONE
	الربته	Oct	
	Oper.	Failur Cat II	
	System Operating	Cat III	×
		Failure Eifect	ing.
		Fallure Mode	I nes of standby toring shillty clearance monit producing no' ing.
OPF STATION	,	Function	
IIS IDFSI	۽	τ. D. Υ΄ρ.	
System SSIIS Subeystem GIIDESLOPE STATION	Identification	Item I	Monitor Channel (Channel Keontinue 3)

Table D-1. Glideslope Failure Analysis (Cont'd)

Subsystem GLIDISLOPE STATION												Page & of 18
Identification	8				System	System Operation	 	Failu	Failure Indications	941	Fallore.	
Item I.	 	Function	Fallure Made	Fallure File 1	Cat III Cat II		ž	Rennie	Control	Other	Pate (	Remarks
Control Unit	5	The control unit processes alarms received from the monitor channels, providing signals to shut down the standby transmitter, to transfer main to standby, in shutdown	Generation of an erroneous transfer eig- nal, due to alarm pro- cessing cir- cuitry.	Causes both the main and the standby trans- mitter to shutdown inmediately after the transfer.			×	MON ABN'' and OFF	TRANS- FER. SHIT- DOWN., and ABNOR- NAI.		,2.805 , 1A	-
		both transmitters, or to indicate a monitor mis- match. In addition, the control unit generates (nhibit signals, displays both locally and remotely transmitter and category status, and displays.	Generation of an erroneous shut-down signal due to alarm pro- cessing cir- cuitry.	Gauses both the main and the standby trans mitter to shutdown immediately.			×	MON ARN ARN OFF	"SHUT- DOWN" and 'ABNOR- MAL		2.004 1.1B	
		aure alarm conditions operational features, such as hypass of monitors. In the minimum select, main unit select, ancompletica, of alarms are also associated with the control unit.	Generation of an erroneous mismatch signal.	Mismatch conditions do not effect category performance; how- ever, failure of its- put gates may be haxardous.	×			ABN.	MIS- MATCH: and and MAL: MAL:	No mis- match on monitor channels.	2. FR	Only input gating circuit-RY may be harardous. (Elfects monitoring circuitry)
	· · · · · · · · · · · · · · · · · · ·		Inability to process a transfer signature of the process and from the fourgral course, sensitivity and/ or clearance monitors.	Cat. Iff parameter monitoring of the integral course, sensitivity, and/or clearance is virtually rendered useless.	×			NO NO NO NO NO NO NO NO NO NO NO NO NO N	NONE		3,470 103 1,249 (rectand) 101 101 101 102 103 103 103 103 103 103 103 103	Redundancy has been facor, porated so that performance downgrade is achieved in the event of a "true Cat. III alarm condition."

Table D-1. Glideslope Failure Analysis (Cont'd)

	Remarks .		Redundancy has been incorporated so that performance down grade is achieved in the event of a 'true near field alarm.condition'.	Not hazardous, mismatch condi- tions do not ef .ct Cat. Ill per- formance.	If a standby transmitter failure also occurs, immediate shut- down upon transfer will result.	Α
Failure	Rate fax 10 1	1.103 \1E	1,737 1,1 F	8 0 × 0	1.3% H1'	* ·
200	Other					No alayms on stby. monitors.
Failure Indications	Control Pait	NONE	NONE	NONE	NONE	"ABNOR- NAL"
Fai	Renotz Control	NONE	NONE	NONE	NONE	MON ABN ABN "MAIN"
Ę	ž					
7	Paillur Cat II	,		7		ж
System Operation	Cat III Cat II	×	×	× .	×	
	Fallure Fifer		System will continue to radate a signal fossibly faulty) during a shutdoun status.	No serious effects on system opera- tion. Monitor mis- matches may not be recognized, but parameter out of tions are still processed normally.	Standby unit moni- torin, is rendered	Causes the standby transmitter to shutdown. Nisin in Cat. If status.
	Failure . Mode .	bility to ceas a chutdown sig- nal, initiated by the mis- alignmy at detector.	frability to process a shrindown size about a straight and double trainform a double trainform a starms.	Inability to process a missratch condition of any or all monitor sets.	Inability to process a standby alarm	Generation of an erroneous standry alarm.
	tunction		Reproduced best availab	from copy.		
tion	I. D. No.	10	Ţ,			
Identification	Item	Continued)				

Table D-1, Glideslope Failure Analysis (Cont'd)

STILL THE STATE OF				Annual Transport			ŀ					Page 3 of 18
Identification	41100				Syntems	System Operation	 	lath	I achire indications	920	Failure	-
Same Name	÷ , ;	Function	Failure Mode	Pathere Fifeet	7 III	יווו ליאי וו	Tā	Prinote	Control	Oher	Rate (2)	Renarks
Control ('nit Frantinued'	ō		Inability to process any or all power' environ- niental alarms.	Insent remote recognition of re- specific alarm conditions loss of doungrade capability environmental alarms.	×	,		NONE	NONF		2.369	Not hazardous-power lenviron- mental alarms merely down- grade performance after a time delay yet both transmitter are still available.
			Generation of an erroneous battery alarm	No effect other than erroneously down- grading the system to Cat. Il status.		×	<del> </del>	POW/ ENVIR ABN and MAIN	ABNOR: NAI. and BATT		0.415 1.K	Not harardous-system still has the ability to operate on both transmitting units.
			Generation of any erron- eous power/ environ- mental mental a battery alarm.	No effect other than an erroneous ab- normal indication.	×	Down- grade to Cat. If af after time delay.		"POW / ENVE ABN" and "MAIN"	AANOR- MAY: and possibly the re- spective power or temp- erature alarm	,	1.73	Not hazardous.
			Generation of an errone- ous control signal that shuts down the realin transmitting unit.	After the main transmitter shuts down, the loss of radiation is detected by the monitor extransfer is latitized to the standby unit.		×		MON ABN" and "STBV"	TRANS.	Alarms on some monitor channels.	, 1 K	Monitor channel alarm lights are unpredictable due to a race condition between the generated inhibit signal and the "no signal' input alarm processing.
			Generation of an errone- an errone- eignal that shutdown the standby transmitting unit	After the standby transmitter shute down, the loss of input signals to the standby monitor bannels erestes standby alarm conditions which are processed normally in the control unit.		<b>×</b>		ABIN ABIN and "MAIN"	"2BK"	Alarms on some standby monitor channels.	N1 v v v	This failure mode is not generated by monitoring circuity; hence, it may occur after a transfer to standby has occurred.

Table D-1. Glideslope Eailure Analysis (Contid)

Identification	ation				System	System Operation	, uo	Fail	Failure Indications	and	Failure	
Item. Name	i. p. ś'n.	Function	Failure	Failure Fife a	C'at III	Alter Failure	وَّدُ	Remote	Control Frit	Other	Rate (Ax 10)	Remarks
feontinued	3		Generation of an erroneous control sig- control sig- down both transmitting unite.	After a total churdown is initiated, the loss of input signals need a simultaneous processing of a transfer and shutdown condition in the control			×	MON ABN and OFF	TRANS- FER. SHUT. DOWN: and. ABN	Alarms on some monitor channels.	6,140 1.5	
			Inability to thutdown either the main or the standby trans mitting unit.	No (ailure effect or indication until another failure occurred in the main or standby unit. At that time all control signals would be processed normally, except the reopecturity would not cease transmitting transmission.	, ,			NONE	XONE	-	1,782 1,19	Not hazardous-performance category downgrade still possible. Note also that frans- fer capability still exists; hence. Cat. Ill performance is not effected.
			Inability to effect is charge of units feeding the antennas.	No failure effect or indication until a transfer command is received due to some other (ailure). At that time all radiation will cease.	×	,		NONF	NONE,		10	Essentially renders the standby transmitter useless.
			Pre-mature change of units feeding the antennas-	If in MAIN, a transfer to STANDBY will occur; if in STAND-BY, a transfer to OFF will occur. This is due to a momentary loss of signal.		X (as- sum- ing ini- tual MAIN status)		MON ABN and STBY	TRANS- FER. and ABN	Alarms on some monitor channels.	0.960 1 R	Essentially renders either the main or standby transmitter useless.

Table D-1. Glideslope Failure Analysis (Cont'd)

Vac 10 of 18		Remarks	Upon the generation of a continuous main inhibit, destin modifications have been incorporated to take awin Cat. III status. Although both transmitters may still be good and monitoring is lost.  151 is similar to 'IH.	Failure mode virtually renders the standby transmitter ineless.	Not hazardous-standby monitoring is meaningless after a transfer.	Cat. III and Cat. Il status taken away although both transmitters are still operational.
	Parlure	Rate (1)	2,514   15   15    15    20,108 (atby. inhibit)   152   2,316 (main inhibit)   152   2,316 (main inhibit)   150	2.658 \11	0.370 'Yru	0.140 \range \text{1.40}
	944	Other		2		, , , , , , , , , , , , , , , , , , , ,
	Failure Indications	Control	ABNOR. MAL.	NONE	NONE	LOC LOC BY PASS'' End "NORMAL!"
	Failt	Remote Control	MON ABN and MAIN	NOWE	NONE	"ABNOR MAL" MAL" Reshing and and "MAIN"
	Ę	Off	×			×
	System Operation	t III Cat II				
	System	Cat III		×	×	•
		Failure Fifect	The respective main and/or standby monitor to character to their hibited and hence, rendered totally useless.	If another failure occurs which initiates a transfer, an immediate shudown will occur since the monitored are not inhibited during the transition period.	No effect on system or operation-merely produces alarms on all standy monitor chamels after a transfer has already occurred due to shothers. Inter-	The control unit can- not process transfer and shutdown com- mand signals and. hence, the entire monitoring is rendered useless.
	Failure		Generation of a continuous ma continuous mandor etando in-hibit to the monitor channels.	Inability to process a main inhibit to the moni- tor charmels.	Inability to process a standby in- hibli to the standby moni- tor channels.	Generation of an erroneous an erroneous locally by-passed signal.
Subsystem GLIDESLOPE STATION		Function	•			
E	٤	<u>.</u>	ö	······································		<u></u>
Subayatem G	Identification	Item Name	Control Unit (continued)			

Table D-1. Glideslope Failure Analysis (Cont'd)

Page 11 of 18		Remarks		` `		The atrap option for SDM alarms will by employed to detect "no signal" input conditions.
	Falluge	Aate,	(Ax 10°)	0.339 Nix 1.464	ر الالال	S11.1
	suo	7.0	Sales S	No alarma present on main cabi- net due to inhibit:		SDM lighte SDM lighte on the corresponduling near field monitor tor channel
,	Fallure Indications	Control	Unit	FER". "SHUT- DOWN". "ABNOR- MAL".	FRONT PANEL LICHTS OFF.	"ABN" and "ME. MATCH'
	Fall	Remote	Control	ABN" and "OFF"	ABN" And "OFF	ABN ABN AAIN
	E C		ö	×		
	System Operation	Feller	11 12			
<		After Fallure	Cat III   Cat II			× .
			remire cuect	All delay circuits produce an alarm output; both a con- tilnuous main and atandby inhibit are generated. An im- mediate shutdown will result due to the near field delay circuits. All control logic is	rendered useless. Both transmitters shutdown; monitors channels, however, are inhibited and, hence, do not	Loss of the input asignal to the corresponding near field monitor channel, causing a monitor tormismatch. Dependence upon remaining two peak detectors/monitors for near field monitoring now dependent upon 1 of 2 near field parameter monitors for system control. Shutdown will result if one of the remaining two peak detector/monitors also fails.
	\\	Fallure	Mode	Loss of -12, volts in control unit power supply.	volts in cortrol unit power supply. (Note: loss of switched 28v is also included.)	Loss of detected out- put signal.
System SSIIS Subsystem GLIDESLOPE STATION	3	L	runciton			Each of the near fleid peak detectors receives its input signal from a near fleid antenna. The received RF signal is representative of the course path alignment. Each peak detector then converts the RF signal into a low frequency signal to be processed by its respective monitor.
TEST TDEST	ron Lon	ī.	Š.	***		30 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
System Si Subsystem Gl	Identification	Item	Neme	Continued)		Near Field Peach Perector #1. #2. or #3

Table D-1. Glideslope Failure Analysis (Cont'd)

ì	Remarke	Note that although both the remaining two pask detectors/ monitors monitor integral course position, only an alarm on one of them is required to initiate a transfer.	Although the remaining two peak detectors fromtior the littingral course width parameter, only an alarm on one of them is vequired to initiate a transfer.	Although there will also be a loss of signal to the standby 1.D monitor, the standby labbit signal will prevent the alarm from being processed.
	Rate	8 1	21.11s	7.115 V31
suo	O	RF and SDM lights 'on' on correspond ing course thank!'	RF. SDM. and DDM on corre- sponding seasitivity monitoric chamel.	RF and SDM lighte SDM lighte ton-on-the cor- responding estandry course monitor channel.
Failure Indications	Control	"ABN" and "MIS. MATCH"	MATCH"	-VBV.
Fall	<u>-</u>	"MCN ABN " and " "MAIN"	"MAN" and "KAR"	
rion	اع	<del></del>	<u> </u>	*
o o	After Fallure			×
System Operation	After	×	×	
1	Failure Effect	Loss of input signal to corresponding monitor, causing a monitor mismatch. Dependence upon remaining two peak detectors/monitors for integral course position (path angle) monitoring. Now dependent upon 1 of 2 course parameter munitors for system control.	Loss of input signal to corresponding seasitivity mositor chamsel, causing a monitor mismatch. Dependence upon remaining few peak detectors/monitors/for increases/framento-ing low dependent upon I of 2 monitoring for system control.	Loss of input signal to the standby course monitor. This, in turn, is processed as a failure in the standby ransmitting unit, causing the standby unit to be shut down.
	Fallure	Loss of de- tected output signal.	Loss of de- tected output signal.	Loss of de- tected output eignal.
	Function	Each of the course peak detectors receives a simulated course position input signal. This input signal is obtained by a combination of signal by proximity probes at the redisting antennas. Each peak detector then converts the RF signal into a low frequency signal.	Each of the sensitivity pask detectors receives a simulated input signal representative of the course width (seth angle width). This input signal is obtained by a combination of signals obtained by proximity probes at the radiating antennas. Each pack detector converse the RF signal into a low frequency signal.	This peak detector re- cetees its input signal directly from the stand- by trazamitting unit after proper attenuation. It essentially converts the standby CSE CSB signal tato a low fre- quency signal.
Ę	1.0	20,	23.	E
Identification	Ikem	Course Peak Detectors #1, #2, or #3 (MAIN)	Sensitivity 7 as, 7 as, 7 as, 7 as, 7 as, 82, or. 93 (MAIN)	Standby Course Peak Detector

Table Dal. Glideslope Failure Analysis (Cont'd)

Page 13 of 18	,	Remarks .	·	Although the remaining two peak detector/monitors monitors the clearance signal parameters only clearance are an alarm on one of them is required to initiate a transfer.	
	Failure	Rate (Ax 1C <sup>6</sup> )	1,115 ) <sup>3,32</sup>	7. 18 X	, , , , , , , , , , , , , , , , , , ,
	one	Other	RF.SDM, and DDM ilghts "on" on the cor- cesponding otandby sensitivity monitor.	RF. SDM. and DDM lights 'on' on corres- ponding clearance monitor chamel.	RF. SDM. and DDM lights 'on' on the cay- responding clearance monitor.
	Failure Indications	Control	.vev.	"ABN" and "MATCH"	.vav
	Fall	Remote	NOM" ABN" bas 'YAAIN"	ABY. ABY. TAKAIN.	ABN:- ABN:- AAIN:- MAIN:-
	uoji	ŏ			
	ratem Operati	Cat II	×	,	×
	System Operation	Cat III	,	×	
,		Fallure Effect	Loss of input signal to the standby sen- stitutey monitor. This, in turn, is processed as a failure in the standby transmitting unit. causing the standby unit to be shut down.	Loss of inpu; signal to corresponding clearance monitor channel, causing a monitor mismatch. Dependence upon re- maining two peak detectors/monitors for clearance para- meter monitoring. Now dependent upon i of 2 clearance monitors for system control.	Loss of the input signal to the standby clearance monitor. This, in turn, is processed as a processed as a tailure, in the standby transmitting unit, causing the standby unit to be shut down.
		Failure Mode	Loss of de- tected output signal.	Loss of de- tected output signal.	Loss of de- rected output signal.
System SSILS Subeyetem GLDDESLOPE STATION		Function	This peak detector re- ceives its input signal from the standby trans- mitting unit. After pro- per attenuation, the liput signal is a com- bination of standby course C+SB and SBO. This RF input signal is converted into a low frequency signal.	Each of the clearance peak detectors receives a simulated clearance imput signal. This shout signal is obtained by a combination of signals obtained from both proces. This RF input signal is then quency signal.	This peak detector receives its input signal from the standby transmitting unit. After proper acteuation, this input signal is simply the standby clearance C45B signal. This RF input signal is then conquency signal.
DES	E Q	ι. ο. No.	32	26. 26.	
Subsystem CLDE	Identification	Item	Standby Senattivity Peak De- tector	Clearance Pask Dc. tectors fl. #2. tectors fl. #2. (MAIN)	Standby Glearance Peak Detector

Table D-1. Glideslope Failure Analysis (Cont'd)

								,			
Idenzification				System	System Operation	uc	Failu	Failure Indications	ans.	Failure	
Name No.	Function	Failure Mode	Fallure Effect	Cat III	After Fallure	ĕ	Remote	Control	Other	Rate 6	Remarks.
Changeover 10 and Test Cir- an	The changeover and test circuits provide the automatic changeover capability for the reductant transmitting units. It selects upon command from the control unit which transmitting unit which transmitting unit and select into the automatand which unit operates into dummy loads.	Inability to changeover transmitting units by switching circuitry.	Although this isillure mode does not immediately effect yestem operation, it does jeopardize Cat. Ill satues. This is due to the fact that any failure on the main unit, which should only generate a changeover to a changeover to a changeover down.	×		ž	NONE	NONE	>	A10A	Essentially renders the standby unit useless.
······································		Pre-mature transfer of transmitting units to antennse by switching.	if in MAIN, a trans- fer to STANDBY will occur; if in STAND- BY, a transfer to OFF will occur. This is due to a momen- tary loss of rignal.		X (assuming inf- tist MANIN status)		ABN" ABN" and STBY"	"ABN" and TRANS-	Alarma on some monitor channels.	0.134 <sup>A</sup> 10B	Essentially renders either the main or standby transmitter useless.
		Fallure caus- ing a loss (or incorrect) signal to one of the standby monitors.	The slarm on the standy monitor will shut down the standy transmitting unit - the rasis unit con-times to operate normally.		×	62.4	ABN" and "MAIN"	ABN	Alarm's) on res- pective standby monitor chamel.	0.572 \^10C	A standby monitoring elecultry failure.
		Total loss (or Incorrect phasing of course SBO signal of the main transmitting unit.	Alarms on monitors channels initiate a transfer to standby and system operates on standby.		×		ABN" sad "STBY"	"ABN" and "TRANS- FER"	Alstme on sensitivity monitor channels.	,0000 1000	•

Table D-1. Glideslope Failure Analysis (Cont'd)

System Subayatem G	SILS	System SSIIS Subaystem GLIDESLOPE STATION									Page 15 of 18
and the state of t					System Operation	ration	-	Failure Indications			
Item	G. Š	Fenction	Failure Mode	Fallure Effert	Cat III Cat II	n Ort	Remote	Control	Ocher	Rate (Ax 10 <sup>6</sup> )	Remarks
Changeover and Test Circu'is (continued)	0		Loss of any one or all of. CSF C+SB. CSF SBO. CJ. C+SB. (to main trens- mitter)	Immediate shutdown after an automatic transfer	· · · · · · · · · · · · · · · · · · ·	×	MON ABN'' And 'OFF''	"ABN". "TRANS. FER" and "SHUT. DOWN".	Alarms on some monit tor chan- nels.	A10E 1 Oct 1	2
Distribution Cicuits (Antennas included)	=	The UHF distribution circuits combine and distribute the CSF C45B. CSF 580, and C1. C45B signals to the three 2- lambda antennas.	A loss, de- gradation, or incorrect phasing of any signal feeding any one of the antennas.	Since a failure of this type is independent of the transmitting unit (signal paths common to both transmitters), an ammediate shudown after an automatic transfer will result.		×	ABN" ABN" And	"ABN" and "TRANS- FER" and "SHUT-	Alarms on any or all of the monitor channels.	),11 \11	It should be noted that since any signal degradation sufficient to be 'out of Cat. Ill'iolerance' has the same net effect, all possible failure modes may be treated on an aggregate basis.
UHF Recombining Circuite and Probes (pask detectors excluded)	22	The UHF recombining circuits, receiving in puts from proximity detector probes, combine the CSE C+SB, CSE SBO and CI.C+SB to provide inputs to monitoring the course position, displacement sensitivity, and clearance radiation.	A loss, de- gradation, or incorrect phase of any signal feed : ing any of the monitors.	The actual field radiation is uneffected. However, the monitor channels believe an "out of tolerance" condition exists and initiate a transfer, since the circuitry its common to both transmitting unit, the monitors will again sense an "out of tolerance" condition and initiate a shut-down.		<b>X</b>	ABN and OFF	"ABN" and "TRANS- FER" and SHUT- DOWN"	Alarms on any or all on any or all or	, 1, 2 , 1, 2	
Near Field Antenna and Dower Spitter (peak Getectors ex- cluded)	18	Provides the input for the three near field monitors.	A loss or de- gradation of signal feed- ing the moni- tors.	The erroneous for total loss off signal is processed as a near field alarm, resulting in a transfer and a shutdown after the norminal time delay		×	ABN".	"ABN"  and "TRANS- FER"  And "SHUT- DOWN"	Alarms on near field monitors.	81.	

Table D. 1. Glideslope Failure Analysis (Cont'd)

Page 16 of 18		Remarke	Not hazardous-redundancy of remaining charger and the two, batteries provide negligible prubability of station shutdown.	Not hazardous-both transmitters still available after downgrade.	Not hazardous a total discharge of the batteries can occur only after the system is operated on batteries for some extended periol of time (greater than 3 hours). System operation on batteries is a result of either primary power failure or a failure of both charges - both of which would downgrade performance to Cat. II.
	Failure	Rate (102)	10.477 ANA	0.801 <sup>A</sup> NB	6.436 NAC
	ons	Other	charger fail" light "on" on charger.	"charger fail" and/ or "AC power fail" light 'on' on re- spective charger.	·
	Failure Indications	Control Unit	"ABN"  RAILURE  FAILURE	"ABN" and "CHARGER FAILURE" and for "AC POW-	NONE
	Fall	Remate Control	"PWR/ Envir Abn" and "Main"	"PWR/ ENVIR ABN" and "MAIN"	NONE
	ro.	ğ		,	
	Operal	After Fallure	Lown- grade to Cat. Il after time delay.	Bown- grade to Cat. Il after time delay.	,
	System Operation	Cat III	×	×	×
		Failure Fifect	When one charger fails (total loss of output voltage), the remaining charger supplies the necessary load voltage and current to continu. It also still supplies the voltage to maintain full charge on both batteries.	No immediate effect on system operation- after the pre-set time delay the sys- tem will be falsely dongraded to Cat.	With the loss of the equality con one charger, the remaining charger can still provide the equality as long as the batteries are not totally discharged.
	Failure		Loss of charger out- tharger out- (Note the rouninal out- put volts DC)	Charger failure indi- cation only while output voltage is still main- tained on both chargers.	Loss of equalite voltage capability-sither meanual and / or automatic. Note: the copulite copulite copulity is a mambal 33 voltage is a mambal 34 voltage is a mambal 35 voltage is the batteriel.
Subsystem GLIDESLOPE STATION		Function	The two bittery chargera which are essentially in parallel, eupply all the equipment of the gilderelectric power to all the equipment of the gilder is supplying the power to the electronic equipment, each battery charger ensures that a full charge is constantly maintained on both	batteries. In the event of a primary power fallure the two batteries (in parallel) butteries ypc power.	
ross	ě	I.D. No.	n 5 <del>+</del>		
Subayetem G	Identification	Item Name	Battery Charger #1 or #2		

Table D-1. Glideslope Failure Analysis (Cont'd)

Page 17 of 18	Pailuré	Rate Remarks	6.598 To result in a station shutdorm $^{\lambda}_{N}$ both converters must fail.	0.100 Not hazardous - both transmitters  Agrae atter downgrade.	0.100 Not hazardous - if temperature  ), 7B effects system operation, other alarms will occur.	<sup>4,</sup> 915 <sup>3,</sup> 49, A
	suo:	Other			3	,
	Failure Indications	Control	"ABN" and "CON- VERTER :FAIL"	"ABN" and "TEMP"	NONE	"ABN" and "SHUT. "SHUT. "SHUT. "SHUT. "AND AND AND AND AND AND ALARM"
	Fail	Remote	"PWR/ ENVIR ABN" and "MAIN"	"PWR / ENVIR ABN" and "MAIN"	NONE	ABN" ABN" ABd
	lion	ةً إ	-			×
	Opera	After Failure	Down	Down- grade to Cat. Il after time delay.		
	System Operation	Cat III	×	×	×	
		Failure Fifect	Station maintains normal operation on remaining conversion ovoltages. Fach of the converter voltages is sensed in the control unit for abnormal tolerances.	System maintains normal operation - only an erroneous failure indication.	There are two sen- sors (thermocouples) one for high tempera- tures and one for low temperatures. A tailure of this type in one of the sensors does not effect the operation of the operation of the only effect is the loss of temp. monitoring; ability for only one temperature extreme thigh or low).	Erroneour shutdown of the glideslope station.
		Failure	loss of Sny one or all of the following voltages: 45.5V, -18V, -50V,	Failure producing an alarm indication.	Failure producing no alarm indication.	Loss of alignment detection, producing praducing
Subsystem GLIDESTOPE STATION		Function	Fach of the DC'DC converters transforms the +10 voits nominal input voltage to three different output voltages - +5.5V. INV. and -50V. The couput voltages of each converter are respectively used in parallel and feed both modulators in the system.	The temperature aensors Fallure p provide alarm indications ducing an whenever the temperature alarm exceeds on drops below indication fimits are set to give	indication of air-condi- tioner/heater failures.	The misalignment de- tector detects perma- nent misalignment or deformation of the glideslope antenna tower. A nominal 135 seconds delay is pro- vided to process alarnas, since tower vibrations and wing loadings can
LIDES	ion	. o.	20 24 24 24 24 24 24 24 24 24 24 24 24 24	17		<b>\$</b>
Subsystem	Identification	liem Name	DC/DC Converter 81 or 82	Temp Sensors		Misalignment Detector

Table D-1. Glideslope Failure Analysis (Cont'd)

Page 18 of 48	,	Remarks	Design modifications have incorporated a "quick test functional check.
	,	· 6	<u> </u>
	Failare	Rate (1) (1)	49.84 19.84
		Other	
	Failure Indications	Control Unit	NONE
	Failu	Remote Control	NONE
	tion	٥	
Subayelem <u>GLIDESLOPE STATION</u>	System Operation	Failur Cat II	
		Cat III	× .
	Fallure Effect		Although the near field modulors, detect field rydis/on, an erroncous signal radiation can still exist since tower misalismment in the horizontal plane width of the gilde path angle and the clearance radiation.  radiation.
	Failure		alignment alignment producing no alarm.
	Function		
	u o	I. D. No.	
Subeyelem	Identification	Item Name	Missilgnment Continued)

Appendix E

Localizer Math Models

## Appendix E Localizer Math Models

This appendix consists of tables E-1 and E-2, referred to in section 8.0, which give, respectively, probability math models for localizer hazardous signal radiation and shutdown.

Localizer Hazardous Signal Radiation Probabilities Table E-1.

ment failure.

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It is noteworthy to mention that to calculate precisely this overall probabil-ity is virtually impossible. However, Note: The failure rate for AMON GSE is worst case since no discrimination is made with regards to RF, SDM, tolerance condition. In many instances, other parameters will also be effected by these failures. Hence, a worst case analysis results. sible: failure mode failure rates have A weekly monitor and control logic preventive maintenance, cycle is as sumed to check, for hidden failures been included which can produce a Cat. III course position DD, A out of the calculation is extremely simpliwhich result in a loss of monitoring and DDM alarms. The failure rate for \, ... is worst case also. Worst case failure rates are again fied by a worst case analysis. used for XMTR<sub>CSEDDM</sub> Remarks IOF MONFE Shilicy. 1983 0.242 × 10-6 149B2 0.533 x 10-6 49BI - 0:102 × 10-0 = 16,325 × 10<sup>56</sup> 1D3 1.244 × 10\*\* XMTR<sub>CSE</sub>DDM 35 0.413 × 10<sup>-6</sup> 37 12.832 × 10<sup>-6</sup> 3F 12.832 × 10<sup>-6</sup> 0, 700 × 10-6 1,58C 1.422 x 10-6 0,140 × 10-" 37B 5.340 x 10-" 12F1 = 1.209 x.10-6 9-01 × 605 °0 = VEI 12D - 0.070 × 10-6 STC , 34.13 3C = 1:302 × 10 Pailure Bate REDUND ID: 1358 XMTR<sub>CSEDDM</sub> . 107 Ē REDUNDFF LOGICFF CA'reFF MONCSE NONFF GATE 1,ocic · (<sup>)</sup>XMTR<sub>CSE</sub>DDM 718.11 The probability of failure of course Cat, Ill DDM integral monitoring circuitry, (hidden failure) . [(,<sup>r</sup>odic<sub>F</sub>,F The probability of a hidden failure in the far field Cst. III DDM monitoring circuitry. INT CSE DOM . 168) \* PXMTRCSE DDM A I'REDUND : 1681 NONFF 168) + (1,0GIC - 168) "MON'CSE \* ('CATE ' 168) \* ('REDUNDFF ' ' CATEFF Probability Calculation × P<sub>MONFF</sub> XMTR<sub>CSEDDM</sub> FidiSi<sub>CSF</sub> DDM PINEGSE DIDM 15.83 PINFCSE DDM PMONFF PMONFF Probability of the radiation of a Note: Far field hazardous DDM signal due to external runway disturbances is not included in this calculation. hazardous course position Gat, III DDM signal due to equip-Description Probability

Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

Page 2.017

Remarks	·	For the probability PF CSEDDM some number must be assumed since this number is unpredictable, being a function of runway activity.  For convenience, let PF CSE DDM
Fatlure Rate Data		MONFF
Probability Calculation	PXMTR <sub>CSE</sub> The probability that an actual hazard ous Cat. Ill course DDM will be radiated, with no other parameters being effected.  PINT <sub>CSE</sub> DDM  1.30 × 10.7  2.24 × 10.7  PMON <sub>F</sub> = 5.519 × 10.7  PMON <sub>F</sub> + 5.032 × 10.7  2.559 × 10.7  PMTR <sub>CSE</sub> DDM  2.743 × 10.7  2.555 × 10.7  PMTR <sub>CSE</sub> DDM  2.743 × 10.7  2.555 × 10.7  2.555 × 10.7  2.555 × 10.7  2.555 × 10.7  2.555 × 10.7  2.743 × 10.7  2.743 × 10.7  2.743 × 10.7  2.743 × 10.7  2.743 × 10.7  2.743 × 10.7  2.743 × 10.7	"FF CSEDDM  ONFF 168)  CATEFF 168)  LOGIC FF 168)  REDUNDFF 168;]
Probability Description	Probability of the radiation of a hazardous course position Cat. III DDM signal due to equipment failure. (continued)	Probability of the radiation of a hazardous signal that is out of Cat. Ill course position tolerance at the far field only.

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Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

Remarks ,	· ·	Note: Since the processing for any parameter is virtually identical in the control unit, the same failure rates for AGATE. LOGICE THE REDUND are utilized. By employing MON. In the calculation of Pin CSE SDM.  Vorst case analysis again recults.
Failure Rate Data		AMON <sub>CSE</sub> = A <sub>3</sub> 58 = A <sub>3</sub> 68 = 378 = 5.390 × 10 <sup>-6</sup> A <sub>GATE</sub> = A <sub>1D1</sub> = 0.140 × .0 <sup>-6</sup> A <sub>COGC</sub> = A <sub>1D2</sub> = 0.700 × 10 <sup>-6</sup> A <sub>XMTR<sub>GSE</sub>SDM</sub> A <sub>3B</sub> = 0.413 × 10 <sup>-6</sup> A <sub>3B</sub> = 0.413 × 10 <sup>-6</sup> A <sub>3B</sub> = 0.070 × 10 <sup>-6</sup> A <sub>12D</sub> = 0.070 × 10 <sup>-6</sup> A <sub>12D</sub> = 0.070 × 10 <sup>-6</sup> A <sub>13D</sub> = 0.599 × 10 <sup>-6</sup> A <sub>13D</sub> = 0.599 × 10 <sup>-6</sup> A <sub>13D</sub> = 0.599 × 10 <sup>-6</sup> A <sub>13D</sub> = 0.509 × 10 <sup>-6</sup>
Probability Calculation	PMONE. The probability of a hidden failure in the far field Cat, III DDM monitoring circuitry.  PMONE.  PFCSDDM The probability that the ILS signal will be out of Cat, III DDM toler.  ance at the far field due to external runway disturbances during the critical landing phase of a Cat, III landing.  P(HS) FF = 5,555 × 10	P(HS) <sub>CSESDM</sub> * PINT <sub>CSESDM</sub> * PXMTR <sub>CSESDM</sub> PINT <sub>CSESDM</sub> * (AMD <sub>CSE</sub> 168) <sup>2</sup> * (AMTE 168) <sup>3</sup> * (AMTE 168)  * (NEDUND 168)  PXMTR <sub>CSESDM</sub> * (NAMTR <sub>CSEDDM</sub> * 168)
Probability Description	Probability of the radiation of a hazardous signal that is out of Cat, Ill course position tolerance at the far field only.  (continued)	Probability of the radiation of a hazardous course position Cat. III SDM signal, i.e., incorrect percentage modulation.

Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

Remarks	-	Worst case analysiy performed.
Failure P.ie		Utilitation of Amon <sub>CSE</sub> and worst case; hence. PINT <sub>CSERF</sub> = PINT <sub>CSEDDM</sub> XMTR <sub>CSERF</sub> ;  XMTR <sub>CSERF</sub> ;  Am = 0.150 x 10 <sup>-6</sup> Am = 0.509 x 10 <sup>-6</sup> Am = 0.509 x 10 <sup>-6</sup> Am = 0.509 x 10 <sup>-6</sup> XMTR <sub>CSERF</sub> Beneral  Table  Amin  Amin  O  O  O  O  O  O  O  O  O  O  O  O  O
Probability Calculation	PINT CSE SDM  The probability of a f. filure of the course Cat. III SDM integral monitoring circuitry. (hidden)  PAMTR CSE SDM  The probability that an actual hazardour Cat. III SDM will be radiated, with no other parameters effected.  PINT CSE SDM  FAMTR CSE SDM  PAMTR CSE SDM  PHES CSE SDM  PHES CSE SDM  1 5.885 × 10 <sup>-4</sup> PHES CSE SDM  PHES CSE SDM  PHES CSE SDM  1 4.971 × 10 <sup>-10</sup>	P(HS) <sub>CSERF</sub> = PINT CSERF * PXMTR <sub>CSERF</sub> 2 PINT <sub>CSERF</sub> = ('MON <sub>CSE</sub> 168) <sup>3</sup> + ('GATE 168) <sup>3</sup> + ('GATE 168) <sup>3</sup> + ('LOGIC' 158) <sup>3</sup> + ('AREDUND' 168) <sup>3</sup> PXMTR <sub>CSERF</sub> = ('XMTR <sub>CSERF</sub> 1'XMTR <sub>CSERF</sub> ('XMTR <sub>CSERF</sub> 'XMTR <sub>CSERF</sub> 'LE8)
Probability Description	Probability of the radiation of a hazardore course position Cat. Ill SDM signal, i.e., incorrect percentage modulation. (continued)	Probability of the radiation of a signal that is cut of Cat. III. limit with respect to course RF power.

Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

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Probability Failure Rate Remarks .	n of a PINT GSE RF  The probability of a failure of the course Cat. III RF integral monitor- ing circuitry. (hidden)  P. XMTR GSE F  The probability that an actual hazard- ous signal outside of Cat. III power innit will be radiated, with no other parameters effected.  PINT GSE F  PINT GSE F  S 447 x 10 <sup>-7</sup> P. XMTR GSE F  PHSI <sub>GSE RF</sub> 1,778 x 10 <sup>-3</sup> PHHSI <sub>GSE RF</sub> 1,502 x 10 <sup>-9</sup>	## P(HS)SEN = PiNTSEN
Probability Description	Probability of the radiation of a signal that is out of Cat. III limits with respect to course RF power.  (continued)	Probability of the radiation of a signal that is out of Cat. III limit with respect to course width, a ensitivity DDM.

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Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

Remarke		As in the case of the course parameters, a general failure rate  () MONGL  within the clearance monitor channels will be utilized, leading to a worst case analysis.  Note: Probabilities of the radiation of a hazardous signal that is out of clearance Cat. All SDM or RF tolerances are virtually zero. This is due to the fact that any change in the percentage of modulation or RF power simultaneously effect the clearance DDM. No isolated failure rates for these two parameters exists.
Failure Rate Data		MON <sub>CL</sub> = \( \frac{43B}{45B} = \frac{44B}{44B} \)  = \( \frac{45B}{45B} = 5.551 \times 10^{-6} \)  \( \text{CATE} = \text{IDI} = 0.140 \times 10^{-6} \) \( \text{LOGIC} = \text{IDI} = 0.140 \times 10^{-6} \) \( \text{REDUND} = \text{IDI} = 0.700 \times 10^{-6} \) \( \text{REDUND} = \text{IDI} = 0.700 \times 10^{-6} \) \( \text{AMTR} = 1.249 \times 10^{-6} \) \( \text{AMTR} = 1.446 \times 10^{-6} \) \( \text{AM} = 7.150 \times 10^{-6} \) \( \text{AM} = 7.150 \times 10^{-6} \) \( \text{AM} = 1.552 \times 10^{-6} \) \( \text{AM} = 0.388 \times 10^{-6} \) \( \text{AM} = 0.756 \times 10^{-6} \) \( \text{AM} = 0.756 \times 10^{-6} \)
Probability Calculation	PINTSEN The probability of a failure of the sensitivity Cat. III DDM integral monitoring circuitry. (hidden)  "P. WATSEN The probability that a signal that is out of Cat. III tolerance for course width be radiated, with no other parameters effected.  PINTSEN + 1,301 × 10 <sup>-14</sup> + 0.247 × 10 <sup>-7</sup> = 2,606 × 10 <sup>-7</sup> PXMTR <sub>SEN</sub> F(HS) <sub>SEN</sub> = 3,354 × 10 <sup>-4</sup>	P(HS)  - PXMTR <sub>CLDDM</sub> - PXMTR <sub>CLDDM</sub> - PINT  - (AMON <sub>CL</sub> + (AMON <sub>CL</sub> + (AMON <sub>CL</sub> - (AMON <sub>CL</sub>
Probibility Description	Probability of the radiation of a signal that is out of Cat. III limit with raspect to course width-sensitivity DDM. (continued)	Probability of the radiation of a hazardous signal that is out of clearance Cat. III DDM tolerance.

Table E-1. Localizer Hazardous Signal Radiation Probabilities (Cont'd)

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<u> </u>	
Remarks	
Failure Rate Data	\(\frac{12F1}{12F} = 0.070 \times 10^{-6} \\ \frac{12F}{12F} = 0.070 \times 10^{-6} \\ \frac{14A}{14A} = 1.032 \times 10^{-6} \\ \frac{14A}{14A} = 23.853 \times 10^{-6} \\ \frac{1}{14A} \times 1.032 \times 10^{-6} \\ \frac{1}{14A} \times 1.032 \times 10^{-6} \\ \frac{1}{14A} = 1.032 \\
Probability Calculation	PINT CLDDM  The probability of failure of the clearance Cat. III DDM integral monitoring circuitry. (hidden)  PXMTR CLDDM  The probability that the radiation of the clearance signal will be out of Cat. III tolerance for DDM, with no other parameters effected.  PINT CLDDM  + 1.301 x 10 <sup>-14</sup> + 0.247 x 10 <sup>-7</sup> = 8.944 x 10 <sup>-7</sup> PXMTR CLDDM  P(HS) <sub>CLDDM</sub> P(HS) <sub>CLDDM</sub> P(HS) <sub>CLDDM</sub> = 3.584 x 10 <sup>-9</sup>
Probability Description	Probability of the radiation of a hazardous signal that is out of clearance Cat, ill DDM toler-ance.  (continued)

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Table E-2. Localizer Shutdown Probabilities

	Remarks .	The subscript on A refers to the failure mode; hence, failure rate identification is readily accompilahed.
	Failuro Rate Data	A = 1.827 × 10 <sup>-6</sup> A = 3.507 × 10 <sup>-6</sup> A = 0.140 × 10 <sup>-6</sup> A = 0.140 × 10 <sup>-6</sup> A = 1.506 × 10 <sup>-6</sup> A = 1.506 × 10 <sup>-6</sup> A = 1.508 × 10 <sup>-6</sup> A = 1.032 × 10 <sup>-6</sup> A = 0.859 × 20 <sup>-6</sup> A = 0.0859 × 20 <sup>-6</sup> A = 0.0859 × 20 <sup>-6</sup> A = 0.290 × 10 <sup>-6</sup> A = 0.290 × 10 <sup>-6</sup> A = 0.290 × 10 <sup>-6</sup> A = 0.252 × 10 <sup>-6</sup> A = 0.252 × 10 <sup>-6</sup> A = 0.525 ×
	Probability Calculation	P <sub>S</sub> = E <sup>S</sup> Single Fallures : 10 SEC  P <sub>S</sub> = (14.083 × 10 <sup>-6</sup> × 10/3600  P <sub>S</sub> = 3.912 × 10 <sup>-8</sup>
	Probability Deccription	Single failures in the localizer equipment that cause immediate localizer shutdown.

Table E-2. Localizer Shutdown Probabilities (Cont'd)

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Remarks	Any failure mode of $\lambda_A$ with any other failure mode of $\lambda_B$ will shut down the localizer station.  Note that all failure modes considered in $\lambda_A$ and $\lambda_B$ are free of hidden failures; hence, the 10 second time interval for probability calculations is common to all failure modes.
Failure Raie Data	λ <sub>2</sub> : λ <sub>2</sub> A = 1.446 × 10-6 λ <sub>2</sub> B = 7.150 × 10-6 λ <sub>4</sub> A = 1.446 × 10-6 λ <sub>5</sub> = 10.250 × 10-6 λ <sub>7</sub> = 2.413 × 10-6 λ <sub>8</sub> = 0.413 × 10-6 λ <sub>9</sub> = 0.413 × 10-6 λ <sub>1</sub> = 0.413 × 10-6 λ <sub>1</sub> = 0.388 × 10-6 λ <sub>2</sub> = 0.070 × 10-6 λ <sub>2</sub> = 0.070 × 10-6 λ <sub>2</sub> = 0.070 × 10-6 λ <sub>3</sub> = 0.070 × 10-6 λ <sub>4</sub> = 0.070 × 10-6 λ <sub>5</sub> = 0.070 × 10-6 λ <sub>6</sub> = 0.070 × 10-6 λ <sub>7</sub> = 0.070 × 10-6 λ <sub>8</sub> = 0.070 × 10-6
Probability Calculation	PAB = PA · PB PA = The probability of losu of the main stransmitting unit. PB = The probability of losu of the stand-by transmitting unit. PAB = (A · 10 SEC)(A · 10 SEC) PAB = 7.626 × 10^-6 · 10 SEC, PAB = 7.626 × 10^-6 · 10 SEC, 10 SEC) PA: (1.879 × 10^-7) X (1.879 × 10^-7) X (1.871 × 10^-7) 3.516 × 10^-14
Probability Description	Failure in the raain transmitting unit and a failure in the standby transmitting unit. Both failures occur within the critical phase of the Cat. Ill landing illo seconds) and it is immaterial of which failure occurs first.

Table E-2. Localizer Shutdown Probabilities (Cont'd)

Pere 2 of 14

Remarks	
Failure Rate Data	λ <sub>B</sub> : λ <sub>7</sub> A = 1.446 × 10 <sup>-6</sup> λ <sub>7</sub> B = 7.150 × 10 <sup>-6</sup> λ <sub>9</sub> A = 1.446 × 10 <sup>-6</sup> λ <sub>9</sub> A = 7.150 × 10 <sup>-6</sup> λ <sub>10</sub> = 10.250 × 10 <sup>-6</sup> λ <sub>10</sub> = 10.250 × 10 <sup>-6</sup> λ <sub>10</sub> = 0.413 × 10 <sup>-6</sup> λ <sub>10</sub> = 0.413 × 10 <sup>-6</sup> λ <sub>11</sub> = 0.413 × 10 <sup>-6</sup> λ <sub>11</sub> = 0.38 × 10 <sup>-6</sup> λ <sub>11</sub> = 0.39 × 10 <sup>-6</sup> λ <sub>11</sub> = 0.39 × 10 <sup>-6</sup> λ <sub>12</sub> = 0.33 × 10 <sup>-6</sup> λ <sub>13</sub> = 0.15 × 10 <sup>-6</sup> λ <sub>18</sub> = 0.10 × 10 <sup>-6</sup> λ <sub>18</sub>
Probability Calculation	
Probability Description	

Table E-2. Localizer Shutdown Probabilities (Cont'd)

Page 4 of 14  Remarks  The factor $\begin{pmatrix} \lambda_C \\ \lambda + \lambda_C \end{pmatrix}$	is the conditional probability that the hidden failure modes $(\lambda_C)$ will occur prior to a main transmitting unit failure that initiates a transfer $(\lambda_A)$ . A two week preventive maintenance cycle is assumed to check the transfer capability of the localiser station.
--	---

12A = 0. 221 × 10-6

 $\lambda_{c} = 3.723 \times 10^{-6}$   $\lambda_{A} = 67.626 \times 10^{-6}$ 

The probability of the loss of the transfer to standby capability.

 $P_A = 1.879 \times 10^{-7}$  $P_C = (A_C 2 \text{ WK})$ 

Previously identified.

A hidden failure in the equipment F
which essentially inhibits the
transfer capability of the transmitting units and then a failure
in the main transmitting unit.

10 = 0.844 × 10.6

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Failure Rate Data

Probability Calculation

Probability Description

	The factor, $\left(\frac{\lambda_{D}}{\lambda_{A} + \lambda_{D}}\right)$ is the conditional probability that a failure of $\lambda_{D}$ will occur prior to a failure of $\lambda_{A}$ .  Note that after a failure in the main transfer accomplished, standby monitioning is meaningless.
	$^{\lambda}D^{:}$ $^{\lambda}12C = 0.782 \times 10^{-6}$ $^{\lambda}46A = 13.310 \times 10^{-6}$ $^{\lambda}47A = 9.367 \times 10^{-6}$ $^{\lambda}47A = 14.280 \times 10^{-6}$ $^{\lambda}11 = 1.164 \times 10^{-6}$ $^{\lambda}11 = 0.789 \times 10^{-6}$ $^{\lambda}31A = 0.386 \times 10^{-6}$ $^{\lambda}32A = 0.386 \times 10^{-6}$ $^{\lambda}3A = 0.386 \times 10^{-6}$ $^{\lambda}3A = 0.386 \times 10^{-6}$ $^{\lambda}3A = 0.172 \times 10^{-6}$
$P_{C} = \{ \{ \}_{C} = 2 \text{ WK} \}$ = $\{ \}_{C} = 336 \text{ HR} \}$ = $1.251 \times 10^{-3}$ $P_{AC} = 1.227 \times 10^{-11}$	$P_{AD} = \frac{^{A}D}{^{A} + ^{A}D} \qquad (P_{A} \cdot ^{P}D)$ $P_{A} = $ Previously identified. $P_{D} = $ The probability of the loss of the standby transmitting unit due to a failure in the standby monitoring. $P_{A} = 1.879 \times 10^{-7}$ $P_{D} = ^{A}D \cdot 10 \text{ SEC}$ $P_{D} = ^{A}D \cdot 10 \text{ SEC}$ $P_{D} = 1.237 \times 10^{-7}$ $P_{D} = 9.226 \times 10^{-13}$
	A failure in the standby monitor- ing system initiating a shutdown of the standby transmitting unit and then a failure in the main transmitting unit.

Table E-2. Localizer Shutdown Probabilities (Cont'd)

Remarks	Factors (AGB ABCD)  ABCSE  probabilities that compensate for sequence ordering of P46B and PBCSE  Note that worst case foilure rate for ABCSE  whas been used a new some of the failure rate of ABCSE  the failure rate of ABCSE  produce a sensitivity Cat. III DDM alarm. Also no discrimination has been made as to which course parameter (DDM alarm. Also no discrimination has been made as to which course parameter (DDM alarm. Also no discrimination has been made as to which course parameter (DDM alarm. Also no discrimination has been made as to which course parameter (DDM alarm. Also no discrimination has been made as to which course parameter (DDM alarm. Also no discrimination has been made as to which course parameter (DDM alarm.)	
Failure Sate Data	ABCD: A = 67.626 × 10-6 ABCD: A = 67.346 × 10-6 A = 67.346 × 10-6 A = 3.723 × 10-6 A = 44.514 × 10-6 ABCD = 183.209 × 10-6 ABCD = 183.209 × 10-6 AB = 0.413 × 10-6 AB = 0.413 × 10-6 AB = 11.632 × 10-6 AB = 11.302 × 10-6 AB = 11.302 × 10-6 AB = 11.302 × 10-6 AB = 11.697 × 10-6 AB = 67.626 × 10-6	
Probability Calculation	PSTBY CSE (46B + ABCD) P 46B  x (ABCSE)	
Probability Description	Fallure sequence leading to a shutdown for P.TBV :  (1) Lose of monitoring ability of the standby course monitor.  (2) Failure causing the generation of a faulty course DDM, SDM, or RF parameter from the standby transmitting unit.  (3) Any failure in the main transmitting unit which can initiate at a transfer.	

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Table E-2. Localizer Shutdown Probabilities (Cont'd)

Remarks	Factors (ATB ) and ATB (A+ABCD)  ABSEN  Probabilities that compensate for sequence ordering of PATB and PBSEN.  Note that worst case failure rate for BSEN.  Note that worst case failure rate for BSEN.  Note that worst case failure rate for BSEN.  Produce Cat. Ill course monitor alarm, thus leading to a worst case PSTBYSEN probability calculation.
Failure Rate Data	A <sub>47B</sub> = 2.892 × 10 <sup>-6</sup> A <sub>BCD</sub> = 183.207 × 10 <sup>-6</sup> B <sub>SEN</sub> ; A <sub>BE</sub> = 0.413 × 10 <sup>-6</sup> B <sub>SEN</sub> ; A <sub>BE</sub> = 0.413 × 10 <sup>-6</sup> B <sub>SEN</sub> ; A <sub>BE</sub> = 12.832 × 10 <sup>-6</sup> B <sub>SEN</sub> ; B <sub>SEN</sub> A : 67.626 × 10 <sup>-6</sup> A : 67.626 × 10 <sup>-6</sup>
Probability Calculation	PSTBY SEN (
Probability Description	Sailure sequence leading to a jabutdown for PSTBY.  (1) Loss of monitoring ability of the standby sensitivity monitor.  (2) Failure causing the generation of a faulty course width (IDM) parameter from the standby transmitting wilt.  (3) Any failure in the main transmitting unit which can initiate a transfer.

Table E-2. Localizer Shutdown Probabilities (Cont'd)

Remarks	Factors (A48B + ABCD)  A BCL  probabilities that compensate for sequence ordering of P48B and P C C C C C C C C C C C C C C C C C C
Failure Rate Data	ABB = 5.551 × 10-6 ABCD = 183, 209 × 10-6 ABCD = 183, 209 × 10-6 AB = 7,150 × 10-6 AB = 7,150 × 10-6 AB = 1,552 × 10-6 AB = 0,388 × 10-6 AB = 21,542 × 10-6 ABCD = 183, 209 × 10-6 ABCD
Probability Calculation	PSTBYCL = (ABB + ABCD) P48B  * (A+1BCL) PBCL P48B = * PA Probability of sequence (1) PBCL Probability of sequence (2) PA = 1.879 × 10 <sup>-7</sup> P48B = (P48B = 336 HR) PA = 1.879 × 10 <sup>-5</sup> P48B = (P48B = 336 HR) P5TBYCL = 5.485 × 10 <sup>-5</sup> × (1.749 × 10 <sup>-3</sup> × (1.579 × 10 <sup>-7</sup> ) P5TBYCL = 1.802 × 10 <sup>-14</sup>
Probability Description	Failure sequence leading to a ahutdown for PSTBY C.  (1) Loss of monitoring ability of the standby clearance monitor.  (2) Failure causing the generation of a faulty clearance DDM, SDM, or RF parameter from the standby transmitting unit.  (3) Any failure in the main transmitting unit which can initiate a transfer.

Table E-2. Localizer Shutdown Probabilities (Cont'd)

Remarks	Factors ( 34D + 34K - ABCD) and ( BD
Failure Rate Data	ABCD = 0.350 × 10-6 ABCD = 183.209 × 10-6 ABCD = 183.209 × 10-6 ABCD = 13.134 × 10-6 ABB = 10.318 × 10-6 A
Probability Calculation	PSTEY ID ( 1940 - 194K - ABCD) × (P34D - 194K - ABCD) × (P34D - 194K) / (A + A + A + A + A + A + A + A + A + A
Probabilit Description	Failure sequence leading to a shutdown for FSTBY:  (1) Louis of the monitoring ability of the standby 1.1), monitor.  (2) Failure causing the generation of a faulty 1.D. signal (or loss) of the standby transmitting unit.  (3) Any failure in the main transmitting unit which can initiate a transfer.

Table E-2. Localizer Shutdown Probabilities (Cont'd)

Remarks .	Factors (\( \frac{\lambda_1 + \lambda_{1S1}}{\lambda_1 \lambda_1 + \lambda_{1S1}} + \lambda_B \text{DCD}\)  and (\( \frac{\lambda_2}{\lambda_4 + \lambda_B} \right)\) are conditional gequence ordering of (\( \frac{\lambda_1}{\lambda_1 \text{H}} + \rangle_{1S1} \right)\) and (\( \lambda_2 \right) = 336 \text{ HR} \respectively.\)  Note that the probability (\( \lambda_2 \right) = 336 \text{HR}\) must be used rather than \( \lambda_B \right) \text{because}\) a two week period of failure (preventive maintenance cycle) must be used rather than the 10 second critical landing phase period.  .
Failure Bate Data	$\lambda_{1H}^{A} = 1,399 \times 10^{-6}$ $\lambda_{1S1}^{A} = 0.198 \times 10^{-6}$ $\lambda_{ABCD}^{A} = 183,209 \times 10^{-6}$ $\lambda_{B} = 67,346 \times 10^{-6}$ $\lambda_{A}^{A} = 67,626 \times 10^{-6}$
Probability Calculation	PSTBY = (\frac{\lambda \text{IH} + \lambda \text{151}}{\lambda \text{IH} + \lambda \text{151}} \\ \times \begin{pmatrix} \times \begin{pmatrix} \lambda \text{PH} + \begin{pmatrix} \lambda \text{PH} + \begin{pmatrix} \lambda \text{PH} \\ \times \text{PA} \\ \lambda \text{PA} \\ \text{PD} \\ \text{PA} \\ \text{PD} \\ \text{PA} \\ \text{PD} \\
Probability Description	Failure sequence leading to a shudown for P_STB y: ing ability.  (2) Faifure causing the generation of the standby transmitting unit.  (3) Any failure in the main transmitting unit which can initiate a transfer.

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Table E-2. Localizer Shutdown Probabilities (Cont'd)

Remarks	Note that since a power/environmental alarm will be produced if one of the converters fails, a down-grade from Cat. Ill performance will occur within 3 hours; hence a 3 hour time interval is used.  A monthly preventive maintenance cycle is assumed to check that the far fig'd monitor battery and battery disconnect circuit.	
Failure Rate Data	A <sub>17</sub> 1 <sub>18</sub> 6,598×10 <sup>-6</sup> A <sub>51</sub> A <sub>52</sub> - 4,412×10 <sup>-6</sup> A <sub>50</sub> S <sub>57</sub> 90×10 <sup>-6</sup> A <sub>50</sub> O <sub>519</sub> × 10 <sup>-6</sup> A <sub>70</sub> O <sub>519</sub> × 10 <sup>-6</sup> BATT FF (assumed)	
Probability Calculation	PPSFF  I munitor  SC  SC  SC  SC	
Probability Description	Power supply/converter failures  Poonvaing to a shutdown.  Poonvaing Probability of both main converters failing.  Posper Probability of both far field converters failing.  Probability of the main pow far field monitor failing.  Poonvaine failing	

Table E-2. Localizer Shutdown Probabilities (Cont'd)

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4	Remarks	It should be noted that since an output from the course monitor channel feeds the respective I. D. monitor-things, a worst case analysis may be a complished by treating both on an aggregute basis. Furthermore on an aggregute basis. Furthermore no discrimination is made among the course RF, SDM, and DDM alarmsagain leading to worst case analysis.	Note that it is assumed maintenance action will be employed within 2 weeks (336 HR) after a monitor abnormant
2		it she put find it she	Note actio

Two of the three course/I, D, monito's (including respective peak detectors) failing, producing an alarm,

Probability Calculation

Probability Description CSE/ID1:

= (5.557 × 10<sup>-3</sup>) × (9.188 × 10<sup>-8</sup>) = 5.106 × 10<sup>-10</sup> Note: If each monitor were consid-

Fallure Rate Data

Note that it is assumed maintenance action will be employed within 2 weeks (336 HR) after a monitor abnormal due to a monitor mismatch occurs.		
$\lambda_{35A} = 13.310 \times 10^{-6}$ $\lambda_{20A} = 0.789 \times 10^{-6}$ $\lambda_{20B} = 0.386 \times 10^{-6}$ $\lambda_{34A1} = 1.914 \times 10^{-6}$ $\lambda_{34A1} = 0.140 \times \lambda^{-6}$ $\lambda_{25E/1D_1} = 16.539 \times 10^{-5}$	CSE/ID <sub>2</sub> = \(^36A + ^21A\) \(^2\)21B + \(^3\)34A2\\ \(^1/3^1\)1C1\\ \(^1/3^1\)C1\\ \(^1/3^1\)C1\\ \(^1/3^2\)C1\(^3\) \(^1/3^2\)C2\\ \(^1/3^2\)B + \(^3\)34A3\\ \(^1/3^2\)B + \(^3\)34A3\\ \(^1/3^2\)B + \(^3\)34A3\\ \(^1/3^2\)B + \(^1/3^3\)B	= 16.539 × 10
ered separately, the problem bility of failure or each of the 3 monitors is 1/3 of the above:  CSE/ID1 CSE/ID1 CSE/ID1 (SEE/ID2) * ACSE/ID3	* (\cse/101 \cdot 336 HR) + [(\cse/102 \cdot \cdot SE/103]\cdot \cdot 10 SEC] = 1/3 \cdot (\cdot \cse/10 \cdot 336 HR) + (2 \cdot \cdot \cse/10 \cdot 10 SEC)	•

Table E-2. Localizer Shutdown Probabilities (Cont'd)

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Remarks	
Failure Rate Data	\$EN; \$EN; \$5EN; \$5EN3  \$\frac{1}{2}\$\text{A}\$\text{BEN};  \$\frac{1}{2}\$\text{A}\$\text{BEN};  \$\frac{1}{2}\$\text{A}\$\text{B}\$\text{A}\$\text
Probability Calculation	PSEN SEN 118 + 2 · SEN · 10 SEC - 2.090 × 10 - 10
Probability Description	Two of the sensitivity monitors/ peak detectors failing, producing an alarm.

Table E-2. Localizer Shutdown Probabilities (Cont'd)

<b>5</b> (	Remarko	Worst case analysis is again considered since no discrimination has been made among the clearance DDM, SDM, or RF alarms.
	Failure, Rate Data	\( \lambda \text{CL} = \lambda \text{CL} \right\) \( \lambda \text
	Probability Calculation	P <sub>CL</sub> = ( <sup>C</sup> <sub>CL</sub> · 356 HR)
	Probability Description	Two cf the clearance monitors/ peak detectors falling, producing an alarm,

Table E-2. Localizer Shutdown Probabilities (Cont'd)

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Remarks	Note that the failure of both the DDM and SDM has been included in the near field monitor channel failure rate, since the SDM strap option for a general alarm will be utilized,	Note that the failure rate of the SDM is also included, since the SDM strap option for a general Cat, II alarm will be utilized.  Although a time delay frominal 120 seconds exists at the far field for alarm processing, the 10 sec time interval in the probability calculation is still used. Only the initial arbitrary reference has changed.	
Failure Rate Data	\( \text{NF}^2 \text{NFI} = \text{NF2} \\ \text{NFI} \text{NFI} = \text{NF2} \\ \text{NFI} \text{NFI} = \text{11.099 \text{10}^6} \\ \text{29B} = 0.386 \text{10}^6 \\ \text{29B} = 0.386 \text{10}^6 \\ \text{112} \text{103} = 0.070 \text{10}^6 \\ \text{NFI} = 12/344 \text{10}^6 \\ \text{NFI} = 12/344 \text{10}^6 \\ \text{NFI} = \text{12} \text{30B} \text{113} \text{103} \\ \text{12} \text{12} \text{12} \text{12} \text{12} \\ \text{12} \text{12} \text{12} \text{12} \text{12} \\ \text{12} \text{12} \text{12} \\ \text{12} \text{12} \text{12} \\ \text{12} \text{12} \text{12} \\ \text{12} \text{12} \text{12} \\ \text{12} \text{12} \text{12} \\ \text{12} \text{12} \\ \text{12} \text{12} \\ \t	\frac{\chi_{FF}}{\chi_{50}} \times \frac{\chi_{FF}}{\chi_{50}} \times \frac{\chi_{50}}{\chi_{50}} \times \frac{\chi_{50}}	, 152 2, 310 × 10 <sup>-6</sup> , 1W 0, 140 × 10 <sup>-6</sup>
Probability Calculation	P <sub>NF</sub> = (N <sub>F</sub> · 335 HR)	PFF (FF 330 HR) x {2 · YFF · 16 SEC} c, 081 x 10 · 10	PISHIR (   52 + 1 <sub>1W</sub> ) - 10 SEC 6,822 × 10 <sup>-0</sup>
Probability Description	Both of the near field monitors/ peak detectors failing, producing an alarm.	I wo of the three far field mon- nors/ receivers failing, produc- ing an alarm,	Failure inhibiting the monitors while the ILS signal is radiated. A shutdown status will resultions of Cat. Ill and Cat. Il status.

 $\begin{array}{c} \text{Appendix } \mathbf{F} \\ \\ \text{Glideslope Math Models} \end{array}$ 

## Appendix F Glideslope Math Model's

This appendix consists of tables F-1 and F-2, referred to in section 8.0, which give respectively, probability math models for glideslope hazardous signal radiation and shutdown.

Table F-1. Glideslope Hazardous Signal Radiation Probabilities

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Table F-1. Glideslope Hazardous Signal Radiation Probabilities (Cont'd)

7,1, 7, 14,

Perrarks	Note: Since the processing for any parameter is virtually identical in the control unit, the same failure rates for "GATE" LOGIC" and "REDIND are utilized by employing MONGSE and in the calculation of MONGSE and results.	,
Fadure Pate Data	MONGSE 34B 18B  16B 4.836 × 10-6  16B 4.836 × 10-6  LOGIC 1D2 0.700 × 10-6  LOGIC 1D3 1.249 × 19-6  XMTR GSE SDM  1	
Probability Calculation	PXMTR CSE DDM  The probability that an actual hazardous Cait. Ill course DDM will be radiated, while no other parameters are effected.  PINT CSE DDM  + 1, 301 × 10 <sup>-7</sup> + 6, 247 × 10 <sup>-7</sup> FMON F = 4, 123 × 10 <sup>-7</sup> PMON F = 4, 123 × 10 <sup>-7</sup> FMON F = 4, 123 × 10 <sup>-7</sup> PMON F = 4, 123 × 10 <sup>-7</sup> PMON F = 2, 743 × 10 <sup>-3</sup> PMON F = 6, 88 × 10 <sup>-7</sup> FMON F = 8, 989 × 10 <sup>-16</sup> PMON F = 8, 989 × 10 <sup>-16</sup> PMON F = 8, 989 × 10 <sup>-16</sup> PMON F = 8, 989 × 10 <sup>-16</sup>	P(HS) CSE SDM * PMT CSE SDM * * PMTR CSE SDM * * PMTR CSE SDM + ( MON CSE + ( 168) 3 + ( 100 GC + 168) 4 + ( 100 GC + 160) 4 +
Probability Description	Probability of the radiation of a hazardous course position (path angle) Car. III DDM signal. (continued)	Probability of the radiation of a hazardous course position Cat. III SDM signal signal, i. e., incorrect percentage modulation.

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Table F-1. Glideslope Hazardous Signal Radiation Probabilities (Cont'd)

Remarke	Worst case antiysts performed.
Fallure Rate Data	MONCSE " 34B = 35B  " 36B = 4.836 × 10^6 " 36B = 10 i 40 × 10^6 " LOGIC = 102 = 0.700 × 10^6 " LOGIC = 102 = 0.700 × 10^6 " XMTR GSE   : "
Probability Calculation	PRHS]CSERF * PINT GSERF  * PXMTRGSERF  + (AdATE · 168)  + (AdATE · 168)  + (AdATE · 168)  * (AREDUND · 168)]  * (AREDUND · 168
Probability Description	Probability of the radiation of a signal that is out of Cat. Ill limit with respect to course RF power.

Glideslope Hazardous Signal Radiation Probabilities (Cont'd) Table F-I.

Probability of the radiation of a signal that is out of Cat. Ill limit with respect to course angle widthsensitivity DDM.

Probability Description

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Remarks	Worst case analysis performed.
Fallure Rate Data	MONSEN "38B "38B  = 39B = 2.892 ×:50 <sup>-2</sup> **AATE = 1D1 = 0.140 × 10 <sup>-6</sup> **LOGIC = 1D2 = 0.700 × 10 <sup>-6</sup> **XMTRSEN : **AG = 0.700 × 10 <sup>-6</sup>
Probability Calculation	P(HS) SEN = PINT EN TREEN  PINT SEN + (*AGATE* 168)  + (*AGATE* 168)  * (*REDUND* 168)]  * (*REDUND* 168)]  * (*REDUND* 168)]  PXMTRSEN (*XMTRSEN 168)  The probability of a hidden failure of the sensitivity Gat. III DDM integral monitoring circuitry.  PXMTRSEN 1 III DDM integral monitoring circuitry.  PXMTRSEN 1 III tolerance for course angle width will be radiated while no other parameters are effected.  PINT SEN 1 301 × 10 7 7 6.2.361 × 10 7 7 6.2.47 × 10 7 7 7 6.2.47 × 10 7 7 7 6.2.47 × 10 7 7 7 6.2.47 × 10 7 7 7 6.2.47 × 10 7 7 7 6.2.47 × 10 7 7 7 6.2.47 × 10 7 7 7 6.2.47 × 10 7 7 7 6.2.47 × 10 7 7 7 6.2.47 × 10 7 7 7 7 6.2.47 × 10 7 7 7 7 6.2.47 × 10 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7

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Table F-1. Glideslope Hazardous Signal Radiation Probabilities (Cont'd)

Remarks	Note that by considering the three clearance parameters (DDM, SDM, RF) collectively, a worst case analysis results.	For the probability P <sub>TM</sub> , some number must be assumed since this number is unpredictable, being a function of external and uncontrollable forces. For convanience, let P <sub>TM</sub> = 10 <sup>-5</sup> .
Failure Rate Data	MON <sub>CL</sub> 140B 141B  = '42B 4.848 × 10-6  'GATE AlD1 = 0.140 × 10-6  LOGIC = '1D2 = 0.700 × 10-6  'XMTR C2  'A 1.914 × 10-6  'A	MD: A9B = 2.354 × 10 <sup>-6</sup> A9B = 1.102 × 10 <sup>-6</sup> A = 1.102 × 10 <sup>-6</sup> A MD = 3.456 × 10 <sup>-6</sup>
Probability Calculation	P(IIS) <sub>CL</sub> : P <sub>INT</sub> C <sub>L</sub> P <sub>XMTRC<sub>L</sub> P<sub>INT</sub>C<sub>L</sub> + (3 · <sup>1</sup>/<sub>4</sub>MON<sub>CL</sub> · 168)<sup>3</sup> + f(3 · <sup>1</sup>/<sub>4</sub>GATE · 168)<sup>3</sup> + f(3 · <sup>1</sup>/<sub>4</sub>GGIC · 168) × (<sup>1</sup>/<sub>4</sub>EDUND · 168)  F<sub>MTR</sub>C<sub>L</sub> = (<sup>1</sup>/<sub>4</sub>XMTR<sub>CL</sub> · 168)  P<sub>MTRCL</sub> = (<sup>1</sup>/<sub>4</sub>XMTR<sub>CL</sub> · 168)  F<sub>MT</sub>C<sub>L</sub> = 6.636 × 10<sup>-7</sup>  + 0.740 × 10<sup>-7</sup>  F<sub>MT</sub>C<sub>L</sub> = 1.935 × 10<sup>-3</sup>  F<sub>MT</sub>C<sub>L</sub> = 1.427 × 10<sup>-9</sup></sub>	P(HS)ATM = PMD · PTM PMD = (\langle A_MD · 168HR) = 5.806 × 10-4
Probability Description	Probability of the radiation of a hazardous clearance signal (DDM, SDM, or RF)	Probability of the radiation of a hazardous signal, due to antonna tower misalignment.

Table F-1. Glideslope Hazardous Signal Radiation Probabilities (Cont'd)

age 6 of 6

Remarks	
Fallure Rate Dața	
Probability Calculation	PMD:  The prepability of the loss of tower alignment detection an not not producing an alarm.  PTM:  The probability that the glideslope ant nns tower will become misalgned within the preventive mainenance cycle time of one week. Note-inst the misalignment must effect only the path angle width (sensitivity) or clearance signal, since the course position is field monitored by the near field monitores.  P(HS) = 5,806 × 10 <sup>-9</sup>
Probability Description	Probability of the radiation of a hazardous signed, due to antenna towner missile ment. (continued)

Glideslope Shutdown Probabilities

Table F-2.

The subscript on A refers to the fallure mode; hance, fallure rate identification is readily accomplished. Page 1 of & for the localizer will be employed for the glideelope in specifying and determining probabilities. other failure mode of Ag will shut hidden failures; hence, the 5 second time interval for probability calculations is common to all failure modes. Note: The same nomenclature as Any failure mode of A with any sidered in A app. are free of Any failure mode of 1, with any Note that all failure modes condown the glideslope station. Remarks (failures per million hours) 1R = 0.960 × 10-6 10B = 0.134 × 10-6 A: N2 = 6.734 × 10-6 4A = 1.914 × 10-6 4B = 6.734 × 10-6 5 = 0.686 × 10<sup>-6</sup> 31 = 2.613 × 10 =6 3B = 0.427 × 10-6 3c \* 1.453 × 10 6 3c 1.302 × 10 6 3H = 1.176 × 10"6 0.420 × 10<sup>-6</sup> 10D = 0.070 × 10-6 = 31.455 × 10<sup>-6</sup>  $\lambda_{3F} = 12.832 \times 10^{-6}$ Failure Rate 1AA = 1.464 × 10-6 10E = 1.951 × 10-6 19A = 4.915 × 10-6 10 = 0.140 × 10-6 1z = 6.339 × 10-6 12 × 0.778 × 10-6 1B = 2.004 × 10-6 λ<sub>11</sub> =>1.231 × 10<sup>-6</sup> 18 = 0.098 × 10"6 Σλ. 15.815 × 10<sup>-6</sup> 1A = 2.895'× 19-6 "W × (37,245 × 10<sup>-6</sup> × 5 SEC) = 2.691 × 10<sup>-15</sup> P<sub>S</sub> = 2<sup>3</sup>SINGLE FAILURES 5 SEC P<sub>S</sub> = 15.815 × 10<sup>-6</sup> × 5 SEC P<sub>S</sub> = 2.197 × 10<sup>-8</sup> The probability of loss of the stand-The probability of loss of the main PAB = (AA · SSEC) (AB · SSEC) PAB = (37.455 x 10-6 x 5 SEC) Probability Criculation by transmitting unit. transmitting unit. PAB = PA . PB . a unit and a failure in the standby transmitting unit. Both failures occur within the critical phase of the Cat. Ill landing [5 seconds for glideslope) and it is immaterial of which failure occurs first. Single failures in glideslope equipment that cause immediate glideslope shutdown. Failure in the main transmitting Description Probability

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Table F-2. Glideslope Shutdown Probabilities (Cont'a)

Probability Failure Rate Remarks Calculation Data	atandby failures phase of phase of sterial irr;	P <sub>AC</sub> = γ <sup>λ</sup> <sub>A+</sub> γ <sub>C</sub> (P <sub>A</sub> · P <sub>C</sub> ) A = 37 P <sub>A</sub> = previoualy idantified λ <sub>1</sub> = λ <sub>1</sub> γ <sub>1</sub> γ <sub>2</sub> γ <sub>3</sub> γ <sub>4</sub> γ <sub>2</sub> γ <sub>4</sub>
Probabilit, Description	Failure in the main transmitting unit and 5 failure in the standby transmitting unit. Both failures occur within the critical phase of the Cat. III lunding (5 seconds for glideslope) and it is immaterial of which failure occurs, (ir.; (continued)	# <u>5</u>

Table F-2. Glideslope Shutdown Probabilities (Cont'd)

Remarke	Factors A1B and A7B and A7B ABCD  A BSEN  probabilities that compensate for sequence ordering of P4B and PBEN  Note that worst case failure rate for BSEN  failure rate of ABSEN  duce a Cat. Ill course monitor alarm, thus leading to a worst case PSTBY SEN  probability calculation.
Failure Rate Data	ABCD = 1892 × 10 <sup>-6</sup> ABCD = 118,604 × 10 <sup>-6</sup> ABCD = 10,604 × 10 <sup>-6</sup> BSEN
Probability Calculation	PSTBYSEN
Probability Description	Failure sequence leading to 2 shutdown for PSTBY SEN (1) Loss of monitoring ability of the standby sensitivity monitor.  (2) Failure causing the generation of a faulty path angle course width (DDM) parameter from the standby transmitting unit.  (3) Any failure in the main -ransmitting unit which can initiate a transfer.

Table F-2. Glideslope Shutdown Probabilities (Cont'd)

Remarks	The factor $\left(\frac{\lambda}{\lambda} + \frac{\lambda}{D}\right)$ is the conditional probability that a failure of $\frac{\lambda}{\lambda}$ , will occur prior to a failure of $\frac{\lambda}{\lambda}$ .  Note that after a failure in the main transmitting unit has occurred (a transfer accomplished), standby monitoring is meaningless.	Factors (AsB + ABCD)  A are conditional probacter of the state of the
Failure Rate Data	$\lambda_{A} = 37.455 \times 10^{-6}$ $\lambda_{1} = 1.164 \times 10^{-6}$ $\lambda_{1} = 0.572 \times 10^{-6}$ $\lambda_{4} = 12.699 \times 10^{-6}$ $\lambda_{4} = 13.044 \times 10^{-6}$ $\lambda_{4} = 13.044 \times 10^{-6}$ $\lambda_{3} = 1.115 \times 10^{-6}$ $\lambda_{3} = 1.115 \times 10^{-6}$ $\lambda_{3} = 1.115 \times 10^{-6}$	$ \lambda_{AB} = 4.836 \times 10^{-6} $ $ \lambda_{AB} = 37.245 \times 10^{-6} $ $ \lambda_{B} = 37.245 \times 10^{-6} $ $ \lambda_{D} = 40.181 \times 10^{-6} $ $ \lambda_{BCSE} = 118.604 \times 10^{-6} $ $ \lambda_{BCSE} = 0.686 \times 10^{-6} $ $ \lambda_{TB} = 0.427 \times 10^{-6} $ $ \lambda_{TB} = 12.832 \times 10^{-6} $ $ \lambda_{TB} = 12.832 \times 10^{-6} $ $ \lambda_{TB} = 12.981 \times 10^{-6} $
Probability Calculation	PAD * \frac{1}{\lambda_A + \lambda_D} \left( P_A \cdot P_D \right) \]  P_A = Previously identified. P_D = The probability of the loss of the standby transmitting unit due to a failure in the standby monitoring. P_A = 5.202 \times 10^{-8} P_D = (\lambda_D \cdot 5.5\times 5) P_D = 5.581 \times 10^{-8} P_AD = 1.503 \times 10^{-15}	PSTBY CSE * A6B + ABCD   A6B + ABCD   P6B   X + BCSE
Probability Description	A failure in the of andby monitoring eystem initiating a shutdown of the standby transmitting unit and then a failure in the main transmitting unit.	Fallure sequence leading to a shut- down for STBY CSE:  (1) Loss of monitoring ability of the standby course branifor.  (2) Fallure causing the generation of a faulty course DDM, SDM, or RF parameter from the standby transmitting unit.  (3) Any fallure in the main trans- mitting unit which can initiate a transfer.

Table F-2. Glideslope Shutdown Probabilities (Cont'd)

Remarks	Factors ABB and ABCD  ABCL are conditional  A ABCL  probabilities that compensate for sequence ordering of PaB and PBCL  A worst case probability-calculation is made since the failure rate ABB is nondiscriminatory as to which clearance parameter (DDM, SDM, or RF) is faulty.
Failure Rate Data	ABCD - 118,604 × 10-6 ABCD - 118,604 × 10-6 AB = 6,734 × 10-6 3GL AB = 6,734 × 10-6
Probability Calculation	PSTBYC1. 18B
Probability Description	lure sequence leading to a s down for P T n Y  i) Loss of monitoring ability of the standby clearan c monitor.  i2) Failure causing the generation of a faulty clearance DDH, SDM, or RF parametron DDH, SDM, or RF parameter from the standby transmitting unit.  (3) Any failure in the main transmitting unit which can initiate a transfer.

B Jo 9 SE

Table F-2. Glideslope Shutdown Probabilities (Cont'd)

Remarks	Factors (1) H + 1SI + 1ABCD and (1) H + 1SI and (1) H	Note that since a power/environmental alarm will be produced if one of the converters falls, a downgrade from Gat, III performance will occur within 3 hours; hence, a 3 hour time intervalia used.
Fallure Rate :Data	A <sub>1H</sub> = 1.399 × 10 <sup>-6</sup> A <sub>1S1</sub> = 0.198 × 10 <sup>-6</sup> A <sub>ABCD</sub> = 118.604 × 10 <sup>-6</sup> A <sub>37.455</sub> × 10 <sup>-6</sup> A <sub>B</sub> = 37.245 × 10 <sup>-6</sup> A <sub>B</sub> = 37.245 × 10 <sup>-6</sup>	) 5 = 16 = 0.598 × 10-6
Probability Calculation	PSTBY = \(\frac{1}{1}\text{H} + \frac{1}{1}\text{ISI}\) \times \(\frac{1}{1}\text{H} + \frac{1}{1}\text{ISI}\) \times \(\frac{1}{1}\text{H} + \frac{1}{1}\text{ISI}\) \times \(\frac{1}{1}\text{H} + \frac{1}{1}\text{ISI}\) \times \(\frac{1}{1}\text{H} + \frac{1}{1}\text{SI}\) \times \(\frac{1}\text{SI} + \frac{1}{1}\text{SI}\) \times \(\frac{1}\text{SI} + \frac{1}{1}\text{SI}\) \times \(\frac{1}\text{SI} + \frac{1}{1}\text{SI}\) \times \(\frac{1}\text{SI} + \frac{1}\text{SI}\) \times \(\frac{1}\text{SI} + \frac{1}\text{SI}\) \times \(\frac{1}\text{SI} + \frac{1}\text{SI}\)	P <sub>STBY</sub> = 2.314 × 10 <sup>-15</sup> P <sub>CONV</sub> = (h <sub>15</sub> × 3HR) (h <sub>16</sub> × 5 SEC) h <sub>15</sub> = h <sub>16</sub> = 6.598 × 10 <sup>-6</sup> P <sub>CONV</sub> = Probability of both main converters failing. P <sub>CONV</sub> = 1.814 × 10 <sup>-13</sup>
Probability Description	Failure sequence leading to a shutdown for PSTBY:  (1) Loue of all standby monitoring ability.  (2) Failure causing the generation of any faulty parameter of the standby transmitting unit.  (3) Any failure in the main transmitting unit.  (3) Any failure in the main initiate a transfer.	Converters failures leading to a shuldown.

Table F-2. Glideslope Shutdown Probabilities (Cont'd)

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Remarks	No discrimination is made among the course RF, SDM, and DDM alarms; hence, a worst case analysic results.  Note that if each monitor were considered separately, the probability of failure of each of the 3 monitors is 1/5 of P.CSE.  Note that it is assumid maintenance action will be employed within 2 action will be employed within 2 action will be amonitor mismatch occurs.	
Fajlure Rate	\\ \text{CSE1} = \text{CSE2} = \text{CSE3} \\ \text{CSE1} = \text{CSE1} = \text{CSE2} = \text{CSE3} \\ \text{CSE1} = \text{12,689 \times 10^{-6}} \\ \text{1,93 \text{1,115 \times 10^{-6}}} \\ \text{1,13 \text{1,115 \times 10^{-6}}} \\ \text{CSE1} = \text{13,944 \times 10^{-6}} \\ \text{CSE2} = \text{3,54 \times \text{20} + \text{1/34} \text{1,01}} \\ \text{2,13,944 \times 10^{-6}} \\ \text{CSE3} = \text{3,44 \times 10^{-6}} \\ \text{2,144 \times 10^{-6}} \\ \te	\( \frac{\lambda \text{SEN1}}{\lambda \text{SEN2}} = \frac{\lambda \text{SEN2}}{\lambda \text{SEN1}} = \frac{\lambda \text{SEN2}}{\lambda \text{SEN1}} = \frac{\lambda \text{SEN1}}{\lambda \text{SEN1}} = \frac{\lambda \text{SEN2}}{\lambda \text{SEN1}} = \frac{\lambda \text{SEN2}}{\lambda \text{SEN1}} = \frac{\lambda \text{SEN2}}{\lambda \text{SEN3}} = \frac{\lambda \text{SEN3}}{\lambda SE
Probability	P <sub>CSE</sub> = ( <sup>A</sup> <sub>CSE</sub> · 336 HRS) × ( <sup>2</sup> · <sup>A</sup> <sub>CSE</sub> · 5 SEC) × 1.815 × 10-10	P <sub>SEN</sub> = ( <sup>3</sup> <sub>SEN</sub> · 336 HR) × ( <sup>2</sup> · <sup>3</sup> <sub>SEN</sub> · 5 SEC) = 1,035 × 10
Probability	Two of the three course mont- tors/peak detectors falling, producing an alarm,	Two of the sensitivity monitors/ peak detectors falling, produc- ing an alarm.

Table F-2. Glideslope Shutdown Probabilities (Cont'd)

Remarks	Worst case analysis is again considered since no discrimination han been made among the clearance DDM, SDM, or RF alarms.	Note that the failure of both the DDM and SDM has been included in the near field monitor channel failure rate, since the SDM arrap option for a general alarm will be utilized.	
Failure Rate Data	\( \text{L} \) \( \text{CL1} \) \( \text{A0A} \) = 13.044 \times 10^{-6} \\ \lambda_{25} \) = 1.115 \times 10^{-6} \\ \lambda_{25} \) = 1.115 \times 10^{-6} \\ \lambda_{25} \) = 1.115 \times 10^{-6} \\ \lambda_{CL1} \) = 14.299 \times 10^{-6} \\ \lambda_{CL2} \) \( \text{A1A} \) \( \text{A2A} \	he h	1 <sub>1S</sub> = 2.316 × 10 <sup>-6</sup> 1 <sub>W</sub> = 0.140 × 10 <sup>-6</sup>
Probability Calculation	P <sub>CL</sub> = ( <sup>A</sup> <sub>CL</sub> · 336 HR) * ( <sup>2</sup> · <sup>A</sup> <sub>CL</sub> · 5 SEC) = 1.908 × 10 <sup>-10</sup>	$P_{NF} = {\binom{\lambda_{NF}}{NF}}^{*}$ 336 HR) $\times {\binom{2 \cdot \lambda_{NF}}{NF}}^{*}$ 5 SEC) $\times 1.403 \times 10^{-10}$	PiNHB = (\bar{1}152 + \bar{1}1 w - 5 SEC) = 3.411 × 10^-9
Probability Description	Two of the clearance monitors/ peak detectors failing, produc- ing an alarm,	Two of the near field monitors/ peak detectors falling, produc- ing an alarm,	Failure inhibiting the monitors while the ILS signal is radiated. A shutdown status will result - loss of Cat. III and Cat. II status.

Appendix G

Localizer Preventive Maintenance Checks

## Appendix G

## Localizer Preventive Maintenance Checks

This appendix consisting of table G-1, details the preventive maintenance checks necessary to detect hidden failures in the localizer.

Table G-1. Localizer Preventive Maintenance Checks

ļ 	ļ					
Estimated Task	Time	3.0 min.	0.5 min.	1.0 min.	0.5 min.	(2,0 min.
Recommended Task	Frequency	Weekly	Weekly	Weekly.	Monthly	2 weeks
Preventive Maintenance	Task Description	(1) Flip switch on each monitor to check DDM alarm.  (2) Misalign SDM plase shifter and check SDM alarms: then using front panel meter, realign SDM phase shifter.  (3) Lower course transmitter power, and check RF alarms: then using front panel meter, readjust RF power level,  "Note: Control unit logic for transfer capability may be simultaneously checked """ "local" or "remote" mode of operation is selected.	(1) Flip switch on each monitor to check DDM alarm. "	(1) Flip switch on each monitor to check DDM alarm.* (2) Disconnect output of clearance transmitter to check RF and SDM alarms.*	(1). Flip switch on each monitor to check DDM alarm. Note: Control unit logic for shutdown can be checked simultaneously.	Same as main course monitors except misalignment of standby transmitter:  (1), (2), (3)  **Note: Control unit logic for stand. by alarm processing may be simultaneously checked if "local" or "remote" mode of operation is selected.
Failure Mode		loss of monitering ability, producing no alarms.	Same as above.	Same as above.	Same as above. (Not hazardous)	rass of partition ability, producing no alarm.
uoi	š.	× ÷ i:	38	£ <del>2 4</del> 5	- <del>4</del> 4 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	÷
Identification	liem	Course Monitor Channels (MAIN)	Sensitivity Monitor Channels (MAIN)	Clearance Monitor Channels (MAIN)	Near Field Monitor Channels	Standby Course Monitor Channel

Table G-1. Localizer Preventive Maintenance Checks (Cont'd)

Identification	tion	Failure Mode	Preventive Maintenance	Recommended Task	Estimated	
ltem	No.		Task Description	Frequency	Time	
Standby Sensitivity Monitor Channel	47	I oss of monitoring sbillty, producing no alarm.	(1) Flip switch on monitor to check DDM alarm. **	2 weeks	0.2 min.	1
Standby Clearance Monitor Channel	48	Sanie as above,	(1) Flip switch on monitor to check DDM alarm, ** (2) Disconnect output of clearance transmitter to check RF and SDM alarms, **	2 weeks	0.6 min.	1
Identification Monitor Ass'y	34	loss of one of the main I. D. monitors, producing no starms. (Not hazary', J)	(1) Flip switch on main I.D. unit to "CONTINUOUS" to check if alarms occur on all I.D. monitors.	Monthly	0.5 min.	
		Lose of standby 1. D. monitor. producing no alarm.	(2) Filp switch on standby I. D. unit to "CONTINUOUS" to check if alarm occurs.	2 weeks	0.5 min.	
			Note: I. D. monitor ass'y logic and I. D. centrol unit processing may be checked simultaneously.			
Control Unit	10	Inability to process a transfer signal from the integral course, sensitivity, I.D., and/or clearance monitors.	By checking the individual monitor channel alarms this hidden failure mode can also be checked. Note that the "local" or "remote" mode of operation is required for control unit processing logic checks.	Weekly		ŧ
		Inability to process a shut- dywn signal initiated by the NF. FF, and/or Cat. II course DDM.	Same as above: (indication - "SHUT- DOWN" on control unit front panell.	Monthly		ì
		Inability to process a mis- match condition of any or all monitor sets. (Not hazardous)	Same as above: (indication - "MIS- MATCH" on control unit front panel).	Monthly		ł
		Insbillty to process a standby alarm.	Same as above: (indication - "AB- NORMAL" only on control unit front panel).	2 woeks		<b>-</b> 7
			_			

Table G-1. Localizer Preventive Maintenance Checks (Cont'd)

Page 3 of 5

lden titeation	tron	75 - 11 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	Preventive Maintenance	Recommended	F etimated
!ten	Ϋ́ο.		Task Description	Fréquency	ime
Continued	10	Inability to process any or all power environmental alarms. (Not havardous)	(1) Flip rach voltage circuit breaker switch on each converter and check if "CONVERTER FAII light lights," (2) Flip DC 10AD, and AC IN-PUT circuit breakers and check if CHARGER FAII, and AC FAII lights respectively light.	v months	5.0 min.
		Inability to shutdown either the main or standby transmitting mit.  //or hazardous)	By checking the individual monitor channel alarms this hidden failure mode can also be checked. Note that the local or remote mode of operation is required for control unit processing logic checks.	Monthly	
		Inability to effect a change of units feeding the antennas.	Same as above findication - TRANS-FFR' on control unit front panell.	? weeks	
		Inability to process a main inhibit to the monitor channels.	Same as ahove (note that when two integral monitor alarms exist, a transfer will occur. If an immediate shutdown does not follow (within 2 seconds) the main inhibit is functioning properly. If the alarms are left on longer than 2 seconds - monitor channel simulated alarm with switch - a shutdown will occur.)	2 weeks	
		inability to process a r naby inhibit to the standby i-nibit to the standby monitor channels. (Not hazardous)	Same as above (note that if a standby DiM alarm; s generated from a standby monitor channel, the standby transmitter should shut down and the standby monitor channels be inhibited if the inhibit is not generated, all RF and SDM lights on all standby monitors will light).	Monthly	
		frability to generate a correct shutdown alert signal. (Not hazardous)	Same as above Inote that when the two near field alarms are simulated, a shutdown after a time delay will result. Prior to that shutdown, the shutdown alert should be generated).	Monthly	
		Reproc	Reproduced from Solution best available copy.		

Table G-1. Localizer Preventive Maintenance Checks (Cont'd)

<i>(dentification</i>	E o	:	Preventive Maintenance	Recommended	Estimated
Item	No.	Failure Mode	Task Description	Task Frequency	Tresk
Changeover and Test	21	Inability to changeover transmitting units by switching circuitry.	When the SDM phase abiliter is mis- aligned in checking the SDM monitor- ing circuitry of the course monitors, a transfer and not a shutdown should result to indicate (allure mode has	2 weeks	
Battery Charger	35 91	I oss of the equalize voltage capability. [Not hazardous]	(1) Turn "EOUALIZE TIMER" dial and then check front panel meter to see if voltage is approximately; 33 volts. (each charger) (2) Check respective batteries of each charger to see if full charge has been maintained (all cells).	6 months	15.0 min.
Far Field Monitor Channels	55 57 58	Loss of monitoring ability. producing a Cat. III DDM alarm. (Not hazardous)	(1) Flip switch on each monitor to check DDM slarm. Note: Both hidden failure modes are checked.	Weekly	3.0 min.
		producing no alarms.	Note: FFM combining logic may be simultaneously checked.		
Circuite Circuite	\$	Inability to generate a Cat. III disable signal.	When two far field monitor alarms are activated (above), a Cat. III disable should occur at the remote control toweresiter a nominal 20 second delay. Signal check may be accomplished with a vom.	2 weeks	
		Inability to process a Cat. II monitor alarm. (Not hazardous) Inability to process a shutdown alert. (Not hazardess)	When two far field monitor alarms are activated, both a shutdown alert and a Cat. If monitor alarm (shutdown) should occur after their respective time delays. Signal checks may be accomplished with a VOM.	2 wecks	
		Inability to process a mis- match condition at the FFM. (Not hazardous)	When only one far field monitor alarm is activated, a mismatch signal should occur after a time delay (120 sec). Signal check may be accomplished with a VOM.	2 weeks	

Table G-1. Localizer Preventive Maintenance Checks (Cont'd)

Fatimated		1.0 min.	0.5 m	5.0 min.	2.0 mis.
Perior or ended	A sud-bad g	• dinor	Monthly	6 nombs	Mossbly
Tre entre Maintenance	Task Brac ripping	Turn for field monitor charger circus arraies of and observe CHAPCER FAIL light light, for GM to check FWF TRMP FAIL agnal to be alloge stations.	Turn far field minitor charger cir- cust breaker of and are far field monster maintains normal operation for monster alarma".	He Check terminal unleage of FFM hattery during mercual operation.  (2) Disconnect FFM charger with electronic FFM charger with electronic FFM charger and mbseries a rise in FFM hattery callage (equalize valtage).  Note Above procedure chalas both failure modes.	Control of the state of the sta
		Inability to process a PWB. If MP alaem for either re- n ofe or local displa	In sulfage batery dis- councet circuit fallers, dis- connecting the batters from the load,	I nes o' entalize charge capability after a power outage. f'Not hazardossi Continuous equalize voltage only.	Inability to maintain full charge
4114		•	c v		
identification	lten:	Combining Circuite Lont, uedi	Battery Charger Far Fieldl		FFM

Appendix H
Glideslope Preventive Maintenance Checks

Table H-1. Glideslope Preventive Maintenance Checks

Identification	ton		Preventive Maintenance	Recommended	Estimated
Item	γς.	ranure mode	Task Description	Frequency	Time
Course Monitor Channels (MAIN)	\$ 10 0	Inse of monitoring ability. producing no elarms.	(1) Fifty switch on sach in lifer to chick DDM/Slarm. (2) Misling SDM phase shifter and check SDM alarms; then using front panel meter, realign SDM, phase shifter. (3) Lower course transmitter power, and check RP alarms; then using front panel meter, readjust RF power tevel.  *Note: Control unit logic for transfer capability may be simultaneously checked if Tlocal" or "remote" mode of operation is nelected.	Weekly	3.0 mfn
Senaitivity Monitor Channels (MAIN)	788	Same as above,	(1) Flip switch on each monitor to check DDM alarm."	Weekly	0.5 min.
Clearance Monitor Channels (MAIN)	40 41 42	Same as above.	check DDM alarm, e (2) Disconnect output of clearance transmitter to check RF and SDM alarms.*	Weekly	1.0 min.
Near Field Monitor Channels	£ 4 &	Same as above.	(1) Flip switch on each monitor to check DDM alarm.	Monthly	0.5 min.
Standby Course Monitor Channel	46	Loss of monitoring ability, producing no alarm.	Same as rasin course monitoes except misalignment of staidby transmitter: (1), (2), (3)  reNote Gontrol unit logic for stand-by alarm processing may be simultaneously checked if "local" or "rerrote imode of operation is selected.	2 weeks	2.0 min.
Standby Sonstitivity Monitor Channel	44	Same as above,	(1) Flip switch on monitor to check DDM alarm, **	2 weeks	0.2 min.

Table H-1. Glideslope Preventive Maintenance Checks

Ectimated Tree	Time	0.6 min.	0.2 min. (time delay of 2.25 minutés not included)	,		,		5.0 min.	
Recommended	Frequency	2 weeks	W cekiÿ	Weekly	Weekly		2 weeks	6 months	Monthly
Preventive Maintenance	Task Description	(1) Fitp switch on monitor, to check DDM alarm; ** (2) Disconnect; output of clearance transmitter to check PF, and SDM alarms, **	Flip switch on control unit front panel (MISALIGNMENT DETECTOR TEST switch) to "test" and wait for glideslope shutdown. Note control unit logic is simultaneously checked.	By checking the individual monitor channel alarms this hidden failure mode can also be checked. Note that the "local" or "remote" mode of operation is required for control unli processing logic checks.	Checked by testing the missilgnifient detector alarm when in "local" or "remote" mode of operation.	Checked when tex "monitor channel alarms. (indication - "MISMATCH" on control unit front panel).	Checked when testing monitor channel alarms: (indication - "ABNORMAL" only on control unit front, annel).	(1) Filp each voltage circuit breaker awitch on each conveiler and check if "CONVERTER FAIL" ight lights. (2) Filp "DC LOAD" and "AC IN-PUT" circuit breakers and check if "CHARGER FAIL" and "AC FAIL" lights, respectively light.	By checking the individual monitor channel alarmis this hidden fallure mode can also be checked. Nota-visit the "local" or "remote" mode of openation is required for control unit processing logic/checks.
Sellar Mede		Loss of monitoring ability, producing no alerm.	I oss of alignment detection, producing no alarm.	Inability to process a transfer signal from the integral course, sensitivity, and/or clearance monitors.	Inability to process a shut- down signal initiated by the misalignment; detector.	Insbility to process a mis- match condition of any Or all monitor sets. (Not hazardous)	Inability to process a stand- by alarm.	Inability to process any or all power/environmental alarms. (Not hazardous)	Inability to shutdown either the malticor standby trans-mitting unit. (Not hazardous)
fon	No.	48	. 40	ë			,		, , , , ,
Identification	Item	Standby Clearance Monitor Channel	Misalignment Detector	Control				And the second second second second	

Typie Pal. Tildzslope Preventive Maintenance Checks

,	Time		;			15.0 min.
7.55	Frequency	2 weeks	Z.weeks.	Móathly	2 weeks	6 months
Preventive Maintenance	Task Description	By checking the individual monitor channel alarms this hidden fallure mode can i'so be checked. Note that the 'local' or "remote" mode of operation is required for control unit processing logic checks. (indication transfer on control unit front panell.	Same as above: finite that when two integral monitor alarms exist, a transfer will occur. If an immediate shutdown does not follow (within 2 seconds) the main inhibit is functioning property. Iff the alarms are left on longer than 2 seconds - monitor channel sinulated alarm with switch a shutdown will occur?).	San.e as above: Inote that if a standby DDM alarm is generated from: a standby monitor channel, time standby transmitter should shutdown and this standby monitor channels be inhibited. If the inhibit is not generated, all RF and SDM lights on all standby monitors will light).	When the SDM phase shifter is missaligned in checking the SDM monitoring circuitry of the course monitors, a transfer and not a shutdown should result to indicate failure mode has not occured.	and then check front panel meter to see if voltage is approximately 33 volta. (each charger)  (2) Check respective batteries of each charger to see if full charge has been maintained (all cells).
L'ailte Mode		Inability to effect a change of units feeding the antennas.	inability to process a main inhibit to the monitor chancels.	inability to process a standby inhibit to the standby monitor channels. (Not hazardous)	Inability to changeover trans- mitting unite by switching circuitry.	Ioss of the equalize voltage capability. (Not hazardous)
*>	No.	16		,	10	13
γ.	Item	Continued			Changeover and Test	Battery Charger